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Seattle, WA

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DRAFT
ENVIRONMENTAL IMPACT STATEMENT
SEPTEMBER 1977

METROPOLITAN SEATTLE

REGIONAL ANALYSIS
VOLUME I
KING COUNTY, WASHINGTON

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This Draft Environmental Impact Statement evaluates the environmental, social and economic impacts for alternative wastewater facilities proposed to serve the regional area of metropolitan Seattle. The EIS describes existing wastewater facilities, water quality planning and regulations, and major issues.

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DRAFT ENVIRONMENTAL IMPACT STATEMENT
FOR
METROPOLITAN SEATTLE

Volume I

Regional Analysis

Number: EPA 910/9-77-043A
King County, Washington

Prepared jointly by:
Environmental Protection Agency,
Region X
Seattle, Washington 98101

Municipality of Metropolitan Seattle
Seattle, Washington

Washington State Department of Ecology
Olympia, Washington

With the Assistance of

James M. Montgomery, Consulting Engineers, Inc.
Pasadena, California/Boise, Idaho

Approved by:

Donald P. Dubois
Regional Administrator

August 25, 1977
Date

INTRODUCTION

A. Action Sponsor

The action sponsor is the Municipality of Metropolitan Seattle (METRO) for purposes of compliance with the State Environmental Policy Act (SEPA Chapter 43.21C RCW) and the Federal Environmental Protection Agency for the purposes of compliance with the National Environmental Policy Act (NEPA).

B. Lead Agency, Responsible Official and Contact Person

For NEPA Compliance

Lead Agency: Environmental Protection Agency,
Region X
1200 6th Avenue
Seattle, Washington 98101

Responsible Official: Donald P. DuBois
Regional Administrator

Contact Person: Roger K. Mochnick
Project Officer, Enviromental Evaluation Branch

For SEPA Compliance

Lead Agency: Municipality of Metropolitan Seattle
600 First Avenue
Seattle, Washington 98104

Responsible Official: Neil Peterson
Executive Director

Contact Person: Peter S. Machno
Manager, Environmental Planning Division

C. Authors and Contributors to Draft Environmental Impact Statement

Participating Agencies:	Environmental Protection Agency Department of Ecology Municipality of Metropolitan Seattle
Advisory Agencies:	City of Seattle King County Puget Sound Council of Governments
Consultants:	James M. Montgomery, Consulting Engineers, Inc. (Environmental Impact Statement) Metropolitan Engineers (Facility Plan) Human Resources Planning Institute (Socio-economic studies)

D. Licenses and Permits Required to Implement Wastewater Facilities Plan

Building, grading, complex source permit, shoreline permit and other local governmental permits would be required before implementing most of the alternatives described herein. Eligibility for grant funding by EPA and DOE would be determined after completion of the Final Facility Plan and EIS.

E. Location of EIS Background Data

Municipality of Metropolitan Seattle
Environmental Planning Division
SEPA Information Center
Room 404
600 First Avenue
Seattle, Washington 98104

F. Cost to Public for a Copy of the EIS

No charge while supply lasts.

G. Date of Issue of Draft EIS

This Draft Environmental Impact Statement was made available to the Council on Environmental Quality (CEQ) and the Public on September 23, 1977.

H. Final Due Date for Public and Agency Comments

The final date for submittal of public and agency comments is November 11, 1977. All comments should be sent to Mr. Roger K. Mochnick, Environmental Evaluation Branch, Environmental Protection Agency, 1200 Sixth Avenue, Seattle, WA 98101.

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Metro and EPA Public Information Centers
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Seattle Municipal Reference Library
Metro Library
King County Clerk of the Council
State of Washington--Office of Community Development

Federal Agencies

Council on Environmental Quality
U. S. Department of Agriculture
U. S. Department of Defense
U. S. Department of Interior
U. S. Department of Health, Education and Welfare
U. S. Department of Housing and Urban Development
U. S. Department of Transportation
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National Marine Fisheries Service
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Joel Pritchard, U.S. House of Representatives

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Department of Fisheries
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Department of Social and Health Services
Department of Commerce & Economic Development
The State Ecology Commission
State Parks and Recreation Commission
State Oceanographic Commission
State Utility and Transportation Commission

Local Agencies and Interested Groups

- Metro Council Members
- City of Seattle Agencies:
  - City Council Central Staff
  - Environmental Review Committee
  - Department of Community Development
  - Office of Policy Planning
  - Department of Parks and Recreation
  - Department of Engineering
  - Department of Public Works
  - Water Department
- Port of Seattle, Director of Planning

County Agencies:

- Administrator, King County
- Seattle - King County Department of Health
- Department of Budget & Program Planning
- Department of Planning & Community Development
- Department of Public Works

Puget Sound Council of Governments
Snohomish Metropolitan Municipal Corporation-King County (SNOMET)
Puget Sound Air Pollution Control Agency
Chairperson, Citizen's Water Quality Advisory Committee
Chairperson, Metropolitan Sewer Advisory Committee
City of Renton
City of Edmonds
City of Lynnwood
City of Black Diamond

Distribution List

Metro's component and contracted agencies
National Wildlife Federation
Friends of the Earth
Sierra Club
Audubon Society
Washington Environmental Council
Institute of Environmental Studies (University of Washington)
Ecotope Group

This Draft Environmental Impact Statement was made available to the Council on Environmental Quality (CEQ) and the public on September 23, 1977.

SUMMARY OF DRAFT EIS CONTENTS

This Draft EIS is summarized in terms of the proposal, the alternatives considered, the direct and indirect impacts on the environment, measures to mitigate adverse impacts, and unavoidable adverse impacts.

The Proposal

The Draft Facility Plan, prepared for the Municipality of Metropolitan Seattle, contains alternatives for Puget Sound plants to the year 2005. Alternatives in the Draft Facility Plans are focused on facilities at West Point, Alki, Carkeek Park, and Richmond Beach, but other sites within these designated service areas have been considered in alternatives. The Metro plant at Renton is not included in the proposed facilities, but effects of alternatives on Renton are described since Renton is an integral part of the Metro system.

Regional Alternatives

The Draft EIS analyzes the impacts of the eight regional alternatives proposed in the Draft Facility Plan. Each alternative is evaluated on a co-equal basis in the Draft EIS; no recommended alternative has been selected. The Final EIS will include a recommended alternative and will undergo a 30-day public review period.

Regional alternatives were developed to address, in various combinations, four polar issues: water quality, site impacts, the law (PL 92-500) and costs. Components considered in developing alternatives included service area, collection system and transfer interceptors, treatment process, plant site, treated wastewater discharge location, combined sewer overflow control, and sludge management. Interceptors to service new growth areas were not included.

Two of the alternatives (A and B) are "no action" alternatives required by The Washington State Environmental Policy Act (SEPA) and the National Environmental Policy Act (NEPA). Two of the alternatives (C and D) address combined sewer overflows, which create a local water quality problem. Four alternatives (E, F, G and H) provide secondary treatment and other variable features. From the eight regional alternatives, it is possible to derive hybrid alternatives that select components from more than one alternative and blend them into a new alternative, such as secondary treatment plus combined sewer overflow controls. The eight regional alternatives are summarized below.

Alternative A - No Action

No capital expenditure would be made for expansion, modification or upgrading treatment plants at West Point, Alki, Carkeek Park or Richmond Beach. There would be no construction of new interceptors or increase in plant capacity during the planning period (until 2005). Alternative A is evaluated to meet SEPA "no action" requirements.

Alternative B - Metro Comprehensive Plan -
(No Action Pursuant to PL 92-500)

Plant upgrading and transfer interceptor construction would follow the Metro Comprehensive Plan. Alternative B is evaluated as the "no action" alternative pursuant to Public Law 92-500 (PL 92-500) and NEPA requirements and serves as the baseline for comparing other alternatives. Puget Sound plants (West Point, Alki, Carkeek Park and Richmond Beach) would be retained with primary treatment. Improved sludge management and disinfection practices would be provided in Alternative B and all following alternatives. Four new transfer interceptors and improvements to the Alki outfall would be included.

Alternative C - Major Combined Sewer
Overflow Control

Major portions of combined sewer overflows would be controlled by containment at holding tanks and regulator stations, transfer from fresh to saltwater through a new outfall to Elliott Bay, and/or treatment. The existing Puget Sound plants would be upgraded to provide enhanced primary treatment by physical/chemical treatment of solids during the summer. A new wet weather enchanced primary treatment plant would be constructed in the lower Duwamish industrial area and the Alki plant would be abandoned, both in 1995.

Alternative D - Partial Combined Sewer Overflow Control

Wet weather combined sewer overflows would be reduced to Lake Washington, Lake Union and the West Seattle shoreline by constructing holding tanks, regulator stations, and an outfall to Elliottt Bay. The four Puget Sound plants would be upgraded to enhanced primary treatment with chemical addition during the summer for improved solids removal.

Alternative E - Secondary

Secondary treatment would be added to the West Point, Alki and Richmond Beach wastewater treatment plants by 1985. The Carkeek Park plant would provide primary treatment for wet weather flows only beginning in 1985; dry weather flows would be pumped to West Point. The Carkeek Park plant could be abandoned in 1995 (depending on City of Seattle Sewer separation programs).

Alternative F - Secondary/Southern Strategy

Secondary treatment would be provided at Richmond Beach and West Point (with a reduced service area). A major new secondary treatment facility would be constructed in the Duwamish industrial area in 1985; the Alki plant would be abandoned at that time. A new outfall off Alki Point would be built for discharging effluent from the Duwamish (and Renton) plants. The Carkeek Park plant would provide primary treatment for wet weather flows only beginning in 1985; dry weather flows would be pumped to West Point. The Carkeek Park plant could be abandoned in 1995 (depending on City of Seattle sewer separation programs).

Alternative G - Secondary/West Point Phaseout Option

Secondary treatment would be provided at the Alki and Richmond Beach plants. West Point would continue as a primary treatment plant for wet weather flows only, beginning in 1985. A new secondary treatment plant in the Interbay area (Golf Park site) would be constructed. The Carkeek Park plant would provide primary treatment for wet weather flows only beginning in 1985; dry weather flows would be pumped to West Point. The Carkeek Park plant could be abandoned in 1995 (depending on City of Seattle sewer separation programs).

Alternative H - Deconsolidation/Reclamation

Secondary treatment would be provided at West Point, Alki, Carkeek Park and Richmond Beach. Areas of growth would be served by new inland plants with local effluent and sludge reuse possible. Advanced waste treatment would be provided at new North and South Lake Sammamish plants. A new secondary plant at Kenmore would discharge treated effluent to Puget Sound.

Environmental Impacts

The primary (direct) and secondary (indirect) impacts of each alternative are described in categories in the physical, biological and human environments plus natural resources and energy. The major effects of each alternative are summarized below.

Alternative A - No Action

Alternative A, which would continue sewerage service to the present sewered population but provide no new service or capital improvements, would have comparable impacts in 2005 as existing conditions. Combined sewer overflows (CSO's) would produce localized adverse impacts on inland surface waters (Lake Washington, Portage Bay, Lake Union, Ship Canal) and saltwaters (Elliott Bay and Alki Point). Bacterial levels would probably continue to exceed standards for swimming (Lake Washington) and shellfishing (Carkeek Park and Alki Beach) in some areas. Pollutant discharge to Lake Washington/Ship Canal from combined sewer overflows and to the Duwamish River from the Renton plant would have adverse impacts on fisheries. Eelgrass beds at Alki, important in herring production and local fisheries, could be affected by combined sewer overflows and inadequate dilution at the existing outfall. In Puget Sound, the discharge of solids, metals, toxicants, and other materials would continue at present rates. Although effects as measured to date from present discharges have been very minor, the possibility of subtle, long-term impacts must be considered.

The site impacts on regional park lands or residential areas would continue. The West Point plant would continue operating near Discovery Park and the Carkeek Park plant would remain in that park.

Alternative A would not comply with the secondary treatment requirements of PL 92-500, but the implementation of this alternative is not realistic. It is evaluated merely to show the consequences of no action.

Energy consumed by continued operating practices at West Point, Alki, Carkeek Park and Richmond Beach would be 24 million kilowatt-hours per year, approximately equivalent to the energy consumed annually by 1200 homes.

Capital costs would not be incurred under Alternative A. The estimated Metro user charge, averaged for the next 20 years, would be $5.25 per month per equivalent connection.

Alternative B - Metro Comprehensive Plan - (No Action Pursuant to PL 92-500)

Water quality impacts would increase under Alternative B relative to existing conditions. Combined sewer overflow increases (over present conditions) of 36 percent to some inland waters would produce localized adverse water quality impacts in waters (Lake Washington and Ship Canal) used by migratory and resident fish. Construction of the second Kenmore interceptor could possibly adversely affect salmon spawning areas in a portion of Lake Washington. An indirect impact would be a three-fold increase in discharge from the Renton plant to the Duwamish River, which could adversely affect migrating fish. Shellfishing areas would be less subject to contamination at Alki, due to improvement in the outfall. For Puget Sound, discharge of primary effluent would add more materials that could adversely affect water quality, such as solids, oxygen-demanding materials, bacteria, nutrients and toxicants. Long-term impacts of this discharge are difficult to ascertain, based on limited data, but could be detrimental to Puget Sound.

The site impacts would be approximately the same as in Alternative A, since only minor improvements would be made at plant sites.

This alternative does not comply with the secondary treatment requirements of PL 92-500, but is evaluated to comply with requirements because it represents no action pursuant to PL 92-500 and to reflect Metro's present Comprehensive Plan.

Estimated capital costs would be $82,000,000 (1976 dollars). Assuming construction costs would not be eligible for federal and state grants, the estimated Metro user charge, averaged for the next 20 years, would be approximately $8.40 per month per equivalent connection.

Alternative C - Major Combined Sewer Overflow Control

This alternative would virtually eliminate combined sewer overflow to freshwaters (Lake Washington, Lake Union, Portage Bay and the Ship Canal) but would transfer some overflow to Elliott Bay. Localized moderate-to-major benefits to migratory fish routes and spawning areas would result. However, the discharge of an expanded Renton plant to the Duwamish would have adverse impacts on migratory fish. In addition, the discharge to the Duwamish estuary from the proposed Duwamish wet weather plant could add pollutants to the area, which is already stressed for fish and other biota by oil, grease, ship wastes and poor flushing characteristics. Some shellfishing conditions and public health protection at Alki would improve with the improved outfall there. In Puget Sound, enhanced primary treatment would result in a 20 percent reduction in solids loads relative to Alternative B. However, solids loads to Puget Sound would remain approximately as under existing conditions; an increase in flow would be counteracted by a corresponding decrease in solids concentrations. Therefore, water quality improvements due to Metro discharge are not anticipated.

Construction impacts for the CSO holding tanks and regulator stations could cause temporary disturbances such as noise, odor and traffic disruption. However, once facilities are operational, impacts would be negligible.

Because no substantial changes would be made at the treatment plants, they would still exist in or near parks that provide regional recreational opportunities. Socioeconomic impacts of constructing a new plant in the Duwamish have not been determined yet, but are being studied by Metro. Energy use would be 36 million kilowatt-hours per year, equivalent to consumption from 1800 residential units.

Alternative C does not comply with the PL 92-500 requirements for secondary treatment. Consequences could include penalties and ineligibility for grant funding. Estimated capital costs would be $251,000,000 (1976 dollars). Assuming no federal or state grant funding, the estimated Metro user charge, averaged for the next 20 years, would be approximately $13.70 per month per equivalent connection.

Alternative D - Partial Combined Sewer Overflow Control

Substantial decreases in combined sewer overflows to sensitive freshwaters would result. Lake Washington, in particular, would benefit in localized areas from combined sewer overflow reductions of 83 percent. This was judged as a moderate benefit to salmon spqwning areas. A 50 percent combined sewer overflow decrease to the Ship Canal should benefit migrating fish. The Alki outfall improvement would probably benefit nearby shellfishing areas. Discharge to Puget Sound would be approximately equivalent to Alternative C, wherein water quality improvements were not anticipated due to increases in wastewater flows and continuation of existing pollutant loads.

The treatment plant sites would remain as they are now with little change in the on-site facilities for the chemical storage and additional equipment used in enhanced primary treatment. Plants at West Point and Carkeek Park would continue to exist near regional park lands.

Construction impacts for the CSO holding tanks and regulator stations could cause temporary disturbances such as noise, odor and traffic disruption. However, once facilities are operational, impacts would be negligible.

Energy consumption would be approximately 34 million kilowatt-hours per year, equivalent to the consumption for 1700 residences.

This alternative would not comply with the secondary treatment requirements of PL 92-500, with possible consequences on penalties and funding. Estimated capital costs, principally for transfer and CSO control facilities, would be $107,000,000 (1976 dollars). Assuming facilities would not be eligible for federal and state grants, the estimated Metro user charge, averaged for the next 20 years, would be approximately $11.10 per month per equivalent connection.

Alternative E - Secondary

Secondary treatment would reduce the solids loads (and corresponding metals, oxygen-demanding materials, toxicants, and other contaminants) to Puget Sound by over 70 percent compared to Alternative B. Although the exact impacts of this reduction are not known, it appears to be beneficial from the standpoint of subtle, long-term effects. However, nutrients would probably increase in Puget Sound, which could affect the size of plankton blooms. In addition, this alternative makes little change in combined sewer overflows, which could have localized adverse effects on salmon spawning and beach areas in Lake Washington, plus migratory fish routes in the Ship Canal. Improvements to the Alki outfall could benefit shellfishing and eelgrass beds there. Constructing the Kenmore parallel interceptor could possibly destroy salmon spawning areas in a part of Lake Washington by siltation.

The site impacts would include 12 acres of shoreline fill needed at West Point and expansion of Alki into neighborhood baseball fields.

Energy requirements for secondary treatment would be higher than primary or enhanced primary. Annual energy consumption would be 87 million kilowatt-hours, equivalent to 4300 residential connections.

This alternative would comply with the secondary treatment requirement of PL 92-500. Timing requirements of the NPDES permit dated June 14, 1977 include completion of the Facility Plan and EIS by June 30, 1978 followed by development of a compliance schedule for design and construction to meet the required 1983 date for completion of best practicable treatment facilities. Capital costs are estimated at $213,000,000 (1976 dollars). Assuming all facilities would be eligible for federal and state construction grants, the estimated Metro user charge, averaged for the next 20 years, would be $6.80 per month per equivalent connection.

Alternative F - Secondary/Southern Strategy

Under this alternative, the principal water quality impact would result from combining secondary effluent from the Alki, Renton, and new Duwamish plants discharging to Puget Sound off Alki Point. This discharge would be approximately 26 percent larger in terms of flow than the present West Point discharge. Information on existing conditions off Alki is limited, so more studies are needed before exact impacts can be determined there. A preliminary conclusion is that nutrients from secondary effluent could influence the size of plankton blooms near Restoration Point. Removing the Renton effluent from the Duwamish River would be beneficial in terms of nutrients, dissolved oxygen and migratory fish routes. Alternative F would also reduce combined sewer overflows to inland waters by about 30 percent, a minor improvement to fish spawning areas and migratory routes.

Site impacts would occur at the new Duwamish dry weather plant, but socioeconomic data is not yet available to more accurately describe these impacts. Metro is currently studying the Duwamish area for more information. Some plants in or near parks (West Point, Carkeek Park) would remain, but the Alki plant would be abandoned in 1985.

Energy use would be 81 million kilowatt-hours per year, comparable to the requirements of 4000 residences.

Alternative F complies with the secondary treatment requirements of PL 92-500. The compliance schedule would be developed after June 1978 as discussed previously. Capital costs are estimated at $286,000,000 (1976 dollars). Assuming all facilities are eligible for federal and state grants, the estimated Metro user charge, averaged for the next 20 years, would be approximately $6.85 per month per equivalent connection.

Alternative G - Secondary/West Point Phaseout Option

The water quality impacts on Puget Sound from effluent discharge would be similar to Alternative E because service areas, flow and treatment processes would be the same. Some impacts on Elliott Bay from the new Interbay outfall could be expected. Effects of combined sewer overflows on freshwater would also be the same as in Alternative E. The construction of the Kenmore parallel could possibly destroy some salmon spawning areas by siltation.

The principal difference from Alternative E would be in the site impacts associated with the new Interbay site. The proposed Golf Park site for the Interbay plant would affect local residents by odors during construction and operation; a hard-to-replace recreational facility would be eliminated. (If the optional Commodore Way site were selected, approximately 60 businesses would be removed, with a loss of 700-800 jobs.)

The site impacts at West Point and Carkeek Park would continue as at present until possible phaseout of the plants (possibly 1995 for Carkeek Park, unspecified for West Point), depending on sewer separation and water conservation programs.

Energy use would be 85 million kilowatt-hours per year, comparable to the requirements of 4200 residences.

Alternative G complies with secondary treatment requirements of PL 92-500. The compliance schedule would be developed after June 1978 as above. Estimated capital costs would be $362,000,000 (1976 dollars) which represents a cost over $100,000,000 more for the West Point phaseout option relative to Alternative E. If the facilities are grant-eligible, the estimated Metro user charge, averaged for the next 20 years, would be approximately $7.45 per month.

Alternative H - Deconsolidation/Reclamation

Water quality and related biological benefits from combined sewer overflow reduction under Alternative H would be small; thus, localized spawning or recreational areas along Lake Washington and migratory fish routes through Lake Union would continue to be affected. Impacts on overall quality of Puget Sound would be similar to other secondary alternatives, an anticipated but not quantified improvement. The addition of Kenmore secondary effluent off Richmond Beach could affect water quality and biology there, but little is known of existing conditions. Impacts on inland freshwaters could result from the decentralized plants, particularly in the event of plant malfunction.

Site impacts would include shoreline fill at West Point, expansion to park picnic areas at Carkeek Park and expansion to a baseball field at Alki.

Energy use at 124 million kilowatt-hours per year (equivalent to 6200 residences) would be the highest of all the alternatives because of energy needs for advanced waste treatment.

This alternative would comply with secondary treatment requirements of PL 92-500. Estimated capital costs would be $308,000,000 (1976 dollars). Assuming grant eligibility, the Metro user charge, averaged for the next 20 years, would be $7.85 per month per equivalent connection.

Mitigation Measures

Some measures suggested to mitigate adverse impacts are as follows:

1. Operating enhanced primary treatment year round (Alternative C and D).

2. Improving chlorination application systems (Alternatives B, C, and D).

3. Obtaining socioeconomic information on the Duwamish sites (Alternative C and F).

4. Monitoring water quality, biology and currents to obtain more information prior to constructing new outfalls at Alki (Alternative F), Richmond Beach (Alternative H), or Elliott Bay (Alternatives C, D and G).

5. Industrial pretreatment for West Point or Interbay ervice areas (Alternatives B, C, D, E, F, G and H).

6. Streamflow augmentation in the Duwamish River (Alternative B).

7. Investigation of transfer options other than the Kenmore parallel (Alternatives B, E, G).

Unavoidable Adverse Impacts

The remaining adverse impacts on water quality, biology, socioeconomics, sites, costs, energy and natural resources that could not be mitigated by the previously mentioned measures under each alternative would be unavoidable adverse impacts.

DESCRIPTION OF THE PROPOSAL

A. Name of the Proposal and Sponsors

This information is contained in the Introduction and in the Summary of Draft EIS Contents

B. Location of the Project

The project location is described in Chapters I and III of the Draft EIS.

C. Other Agencies File Numbers on Proposal

The reader is requisted to contact Mr. Roger Mochnick (EPA), Mr. John McDonnell (DOE), and Dr. Peter Machno (Metro) for this information.

D. Identification of Construction Phasing and Future EIS Requirements.

Chapter III contains this information.

E. Description of Physical and Engineering Aspects of the Project

Projects are summarized in the Draft EIS and detailed in the Draft Facility Plan.

F. Land Use Plans and Zoning Regulations

Chapter II of the Draft EIS describes existing and projected land use; Chapter III addresses whether the proposal is consistent with these regulations.

PREFACE

This Draft Environmental Impact Statement (EIS) evaluates the impacts of alternative wastewater facilities described in the Draft Facility Plan developed for the Municipality of Metropolitan Seattle (Metro). The alternatives include wastewater treatment plants, transfer interceptor sewers, combined sewer overflow control facilities and sludge handling facilities that would be constructed and operated by Metro. The major part of construction costs could be provided by grants from the Environmental Protection Agency (EPA) and the Washington State Department of Ecology (DOE).

The EIS has been prepared in response to federal and state legislation plus local resolutions requiring that EPA, DOE and Metro each fully consider the environmental impacts and consequences of alternative projects prior to making a final decision to proceed on a recommended project. The respective responsibilities for the three agencies in the EIS process were established for EPA in the National Environmental Policy Act (NEPA), 42 U.S.C. Sec. 4321, et seq.; for DOE in the Washington State Environmental Policy Act (SEPA) Chapter 43.21C RCW; and for Metro in Metro Council Resolution No. 2582.

In certain cases, significant environmental impacts could result from the various wastewater facilities alternatives. For example, alternatives for Metro's West Point, Alki and Carkeek Park wastewater treatment plants may have significant environmental impacts; similarly an evaluation of facilities on a regional level indicated that some significant impacts should be considered. Therefore, a decision was made to prepare an EIS on these projects to comply with both NEPA and SEPA requirements. Rather than preparing separate EIS documents at the appropriate time, the three agencies agreed to prepare a joint EIS for the regional facilities alternatives, plus the West Point, Alki and Carkeek Park alternatives. In addition to satisfying both NEPA and SEPA with the joint EIS, the agencies also chose a procedure designed to eliminate delays and duplication of effort as well as to facilitate desirable interchange among the agencies and with the public during the early stages of the EIS process.

In another case facilities would not cause significant environmental impacts as defined in NEPA. Therefore, an EIS pursuant to SEPA (which would also serve as an environmental assessment) was prepared for the Richmond Beach site and service area.

Preface

For the total evaluation of the environmental impacts of alternative facilities plans, the environmental analysis has been organized as follows: Regional Analysis EIS (Volume I), West Point Treatment Plant EIS (Volume II), Alki Treatment Plant EIS (Volume II), Carkeek Park Treatment Plant EIS (Volume II), Richmond Beach Treatment Plant EIS (pursuant to SEPA) (Volume II). Each site-specific document (Volume II) is intended to be read with the regional analysis (Volume I), with each such pair constituting a complete EIS.

The production of this joint Draft EIS results from close cooperation between EPA, DOE, and Metro. All three agencies have been intimately involved with the review, analysis, supplementation, and synthesis of materials furnished by independent consultants hired to assist with the preparation of the EIS. The City of Seattle, King County, and the Puget Sound Council of Governments have also participated in meetings and provided comments on preliminary draft materials to ensure that local government concerns and regional land use planning goals were incorporated in the EIS.

EPA regulations on "Preparation of Environmental Impact Statements" (40 CFR Part 6; 40 FR, April 14, 1975), Council on Environmental Quality Guidelines for the "Preparation of Environmental Impact Statements" (40 CFR Part 1500; 38 FR 20550, August 1, 1973), and the EPA "Manual for Preparation Works, Facilities Plans, and 208 Area-wide Treatment Management Plans" (July 1974) have been used in preparation of the EIS. Likewise, SEPA Guidelines, adopted by the State Council on Environmental Quality and incorporated by Metropolitan Council Resolution No. 2582, have been followed insofar as they are consistent with federal requirements.

Some of the alternatives described in the Draft EIS's and Draft Facility Plans include the provision for secondary treatment at Metro facilities by 1985. The twenty year planning period is from 1985-2005. These 1985 dates are not consistent with the current PL 92-500 requirement for Best Practicable Treatment including secondary treatment by 1983. According to the facility planning engineers, the 1985 date may be more realistic than 1983 due to delays in the Step I planning process, and thus in the start dates for Step II (design) and Step III (construction).

However, since the law currently requires Best Practicable Treatment by 1983 the construction schedules will be changed to reflect this. Due to time constraints it was not possible to change the dates in the Draft Plans and EIS's. The reader should note that any mention of secondary treatment in 1985 will be changed to 1983 in the Final Plans and EIS's. The twenty year planning period also changes to 1983-2003.

These changes may impact the analysis of alternatives in several minor ways. First there is a potential for a slight saving in costs, due to the decrease in inflation associated with an earlier start date. However, the need for this earlier start date compresses the design and construction schedules causing an increase in these costs. The two factors, one a potential savings and one in increase in costs, will probably negate one another.

The new planning period from 1983-2003 will cause population projections and solids loading to decrease slightly. This decrease, estimated at 2 percent, is well within current sensitivity of the projections and should not have a noticeable impact on the analysis.

All comments on this Draft EIS should be sent to the EPA as the lead agency in the EIS process. Comments should be addressed to Mr. Roger Mochnick, Environmental Evaluation Branch, Environmental Protection Agency, 1200 Sixth Avenue, Seattle, Washington, 98101. The EPA will then distribute copies of the comments to DOE, Metro and the EIS consultant. Comments will be used by the three agencies in preparing the Final EIS and in their decision-making processes.

It is believed that this process best enables the agencies involved to fully assess and consider all significant physical, economic, and social effects of their proposal, and public input thereon, prior to any significant decision-making step. For this reason, the agencies have not attempted to bias the decision to be reached by recommending any one of the eight alternatives prior to full completion of the EIS process, including the public hearings. Rather, the attempt of this document is to present the decision makers and the public with as complete an analysis as possible of each of the alternatives so that a fully informed decision can be made.

The remaining part of the decision-making process will proceed under the following schedule:

October 25, 1977	Public hearing on Regional Draft EIS
October 26, 1977	Public hearing on West Point Draft EIS
October 27, 1977	Public hearing on Alki Draft EIS
November 1, 1977	Public hearing on Carkeek Park Draft EIS

November 2, 1977	Public hearing on Richmond Beach Draft EIS
November 1977	A preferred alternative is recommended by Metro in conjunction with EPA and DOE
February 1978	Final EIS is available
March 1978	Public hearings on Final EIS
April 1978	Metro Council decision
April 1978	DOE decision
April 1978	EPA decision

CHAPTER I

BACKGROUND

This Draft Environmental Impact Statement (EIS) evaluates the environmental, social and economic impacts for alternative wastewater facilities proposed to serve the regional area of metropolitan Seattle. The following sections describe the EIS organization, existing wastewater facilities, water quality planning and regulations, and major issues.

EIS ORGANIZATION

This Draft EIS identifies the impacts of regional alternatives for wastewater facilities, which would be constructed and operated by the Municipality of Metropolitan Seattle (Metro). The alternatives were developed in the Draft Facility Plan for Upgrading Puget Sound Plants, prepared separately by Metropolitan Engineers and completed in April 1977.

Both the Facility Plan and the EIS are organized as five reports in a series. The first presents alternatives or impacts on a regional basis. The remaining four are site-specific reports focused on the present Metro municipal wastewater treatment facilities for the West Point, Alki, Carkeek Park and Richmond Beach areas.

The Regional Analysis EIS, which is this report, constitutes Volume I of the EIS series. It considers the cumulative or regional impacts from each of the eight alternatives for regional wastewater facilities, as described in the System-Wide Volume of the Draft Facility Plan.

The remaining EIS documents analyze the site-specific issues, alternatives and impacts for the West Point, Alki, Carkeek Park and Richmond Beach plants and service area. Each of the four site reports constitutes a Volume II in the EIS series and evaluates the corresponding alternative facilities described in the site-specific Draft Facility Plans. The Carkeek Park and Richmond Beach EIS documents are confined to evaluating the existing site alternatives and the service area impacts. The West Point EIS, in addition to considering the West Point plant site and service area, discusses impacts for alternative sites in the Interbay area. Similarly, the Alki EIS describes existing site and service area impacts plus those expected at an alternative site in the Duwamish area.

In the Draft EIS series, each alternative defined in the Draft Facility Plan is evaluated on a co-equal basis. No decision or selection of recommended alternatives has been made.

EXISTING WASTEWATER FACILITIES

The existing Metro wastewater facilities are summarized in this section to provide a background for subsequent discussions of alternatives and impacts. For more detail on existing facilities, the reader is referred to Chapter III.

Metro presently operates the largest municipal wastewater collection, treatment and disposal system in the Pacific Northwest. Approximately 710 square miles comprise the Metro planning area, shown in Figure 1-1. Currently, the sewered population within the service area is estimated at 812,000. Metro operates as a wholesale wastewater treatment agency for 33 cities and special districts which in turn provide local and basic collection system services.

The Metro facilities consist of wastewater treatment plants, collection systems, and sludge management facilities, as outlined in Figure 1-2.

Wastewater Treatment Plants

Metro operates four wastewater treatment plants along Puget Sound at West Point, Alki, Carkeek Park and Richmond Beach. A fifth plant is located on the Green-Duwamish River at Renton.

The Puget Sound plants, for which alternatives are being considered in the Draft Facility Plan and Draft EIS, treat an average of 130 million gallons per day (mgd) before discharging the treated wastewater to Puget Sound through outfalls. Average daily flows by plant, calculated from 1973-1975 daily records, are approximately 118 mgd at West Point, 7.5 mgd at Alki, 3.4 mgd at Carkeek Park and 1.5 mgd for

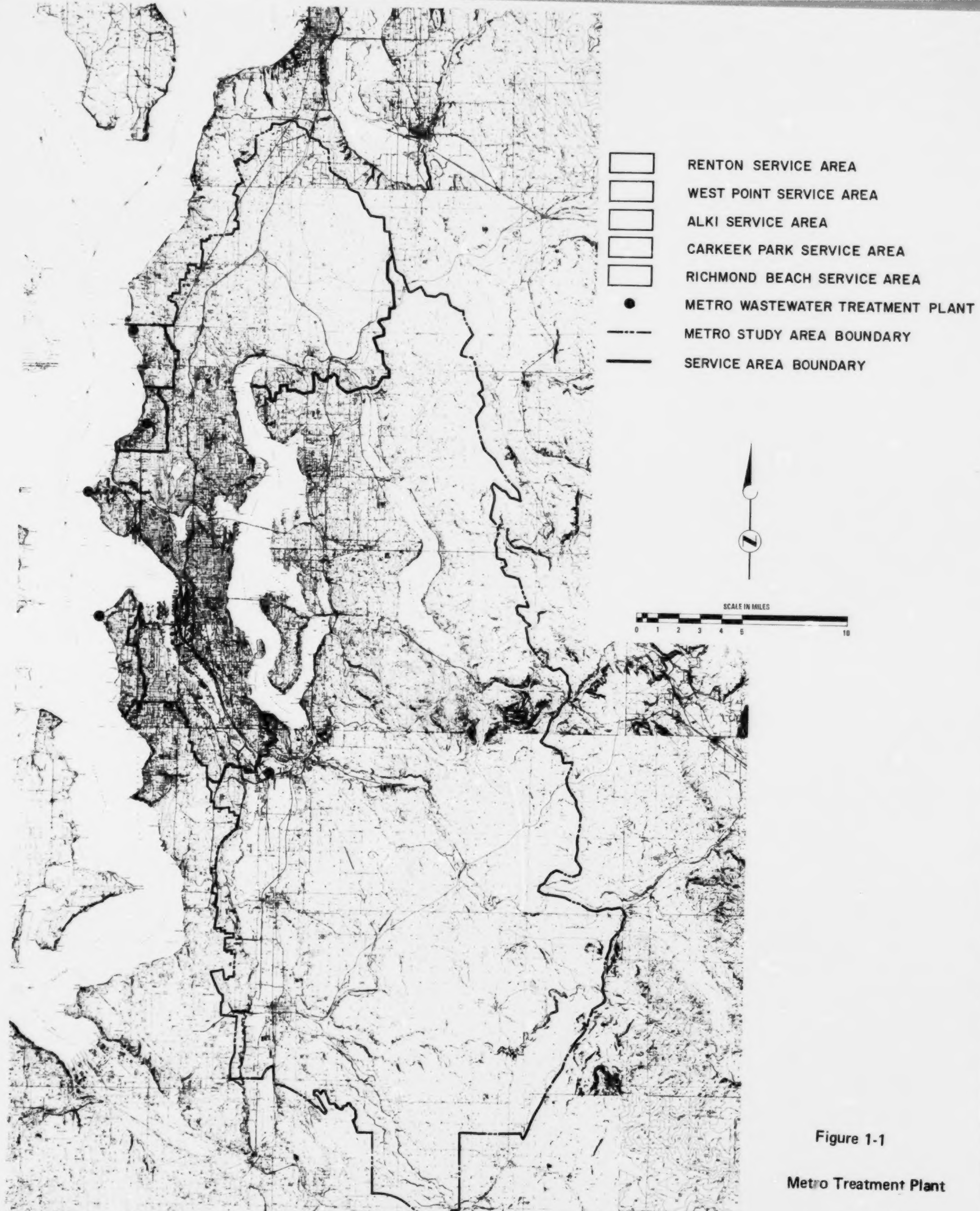
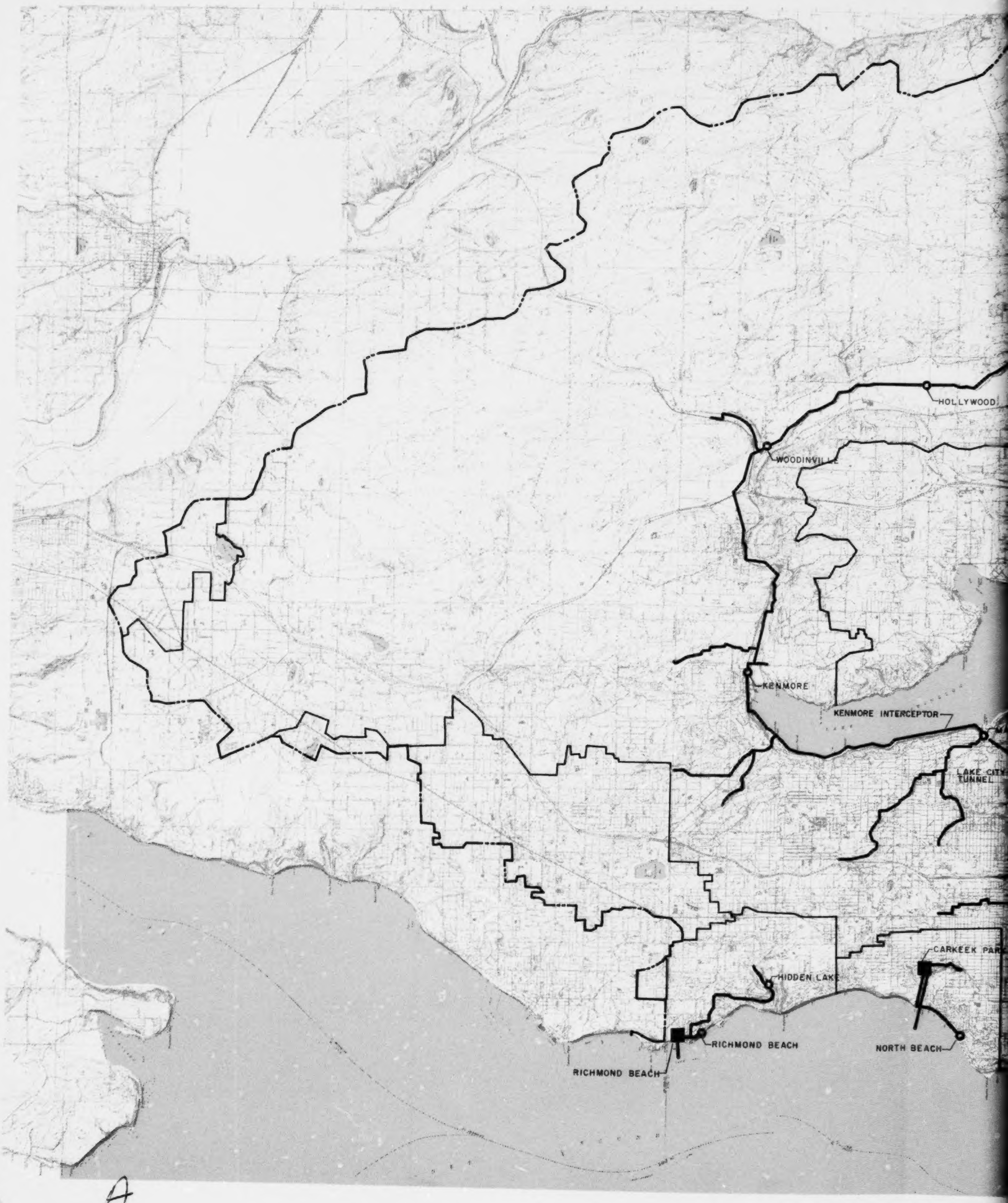

RENTON SERVICE AREA
WEST POINT SERVICE AREA
ALKI SERVICE AREA
CARKEEK PARK SERVICE AREA
RICHMOND BEACH SERVICE AREA
METRO WASTEWATER TREATMENT PLANT
METRO STUDY AREA BOUNDARY
SERVICE AREA BOUNDARY
N
SCALE IN MILES
0
1
2
3
4
5
10

Figure 1-1

Metro Treatment Plant

Service Areas


HOLLYWOOD
WOODINVILLE
KENMORE
KENMORE INTERCEPTOR
LAKE CITY
TUNNEL
CARKEEK PAR
HIDDEN LAKE
RICHMOND BEACH
RICHMOND BEACH
NORTH BEACH

A

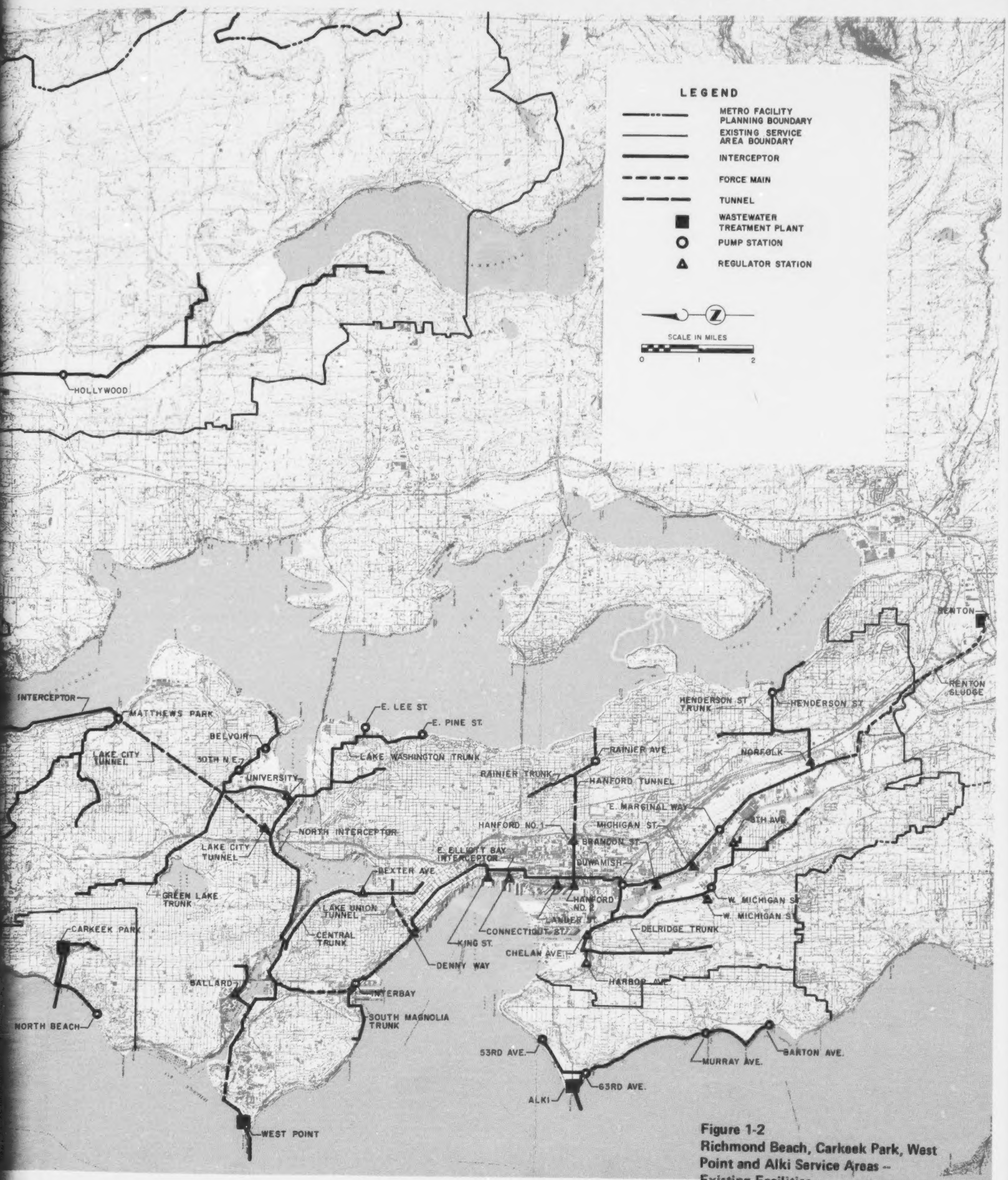

LEGEND
METRO FACILITY PLANNING BOUNDARY
EXISTING SERVICE AREA BOUNDARY
INTERCEPTOR
FORCE MAIN
TUNNEL
■ WASTEWATER TREATMENT PLANT
○ PUMP STATION
▲ REGULATOR STATION
SCALE IN MILES
0
1
2
HOLLYWOOD
RENTON
RENTON SLUDGE
HENDERSON ST TRUNK
HENDERSON ST.
NORFOLK
INTERCEPTOR
MATTHEWS PARK
E. LEE ST.
E. PINE ST.
BELVOIR
LAKE CITY TUNNEL
30TH N.E.
UNIVERSITY
LAKE WASHINGTON TRUNK
RAINIER AVE.
RAINIER TRUNK
HANFORD TUNNEL
E. MARGINAL WAY
NORTH INTERCEPTOR
HANFORD NO.1
MICHIGAN ST.
8TH AVE.
LAKE CITY TUNNEL
BRANDON ST.
E. ELLIOTT BAY INTERCEPTOR
DUWAMISH
DEXTER AVE.
GREEN LAKE TRUNK
HANFORD NO. 2
W. MICHIGAN ST.
W. MICHIGAN ST.
LAKE UNION TUNNEL
LANDER ST.
CARKEEK PARK
CENTRAL TRUNK
CONNECTICUT ST.
DELRIDGE TRUNK
KING ST.
CHELAN AVE.
DENNY WAY
BALLARD
INTERBAY
HARBOR AVE.
NORTH BEACH
SOUTH MAGNOLIA TRUNK
53RD AVE.
BARTON AVE.
MURRAY AVE.
63RD AVE.
ALKI
WEST POINT

Figure 1-2
Richmond Beach, Carkeek Park, West Point and Alki Service Areas -- Existing Facilities

B

Richmond Beach. These four plants provided primary treatment, which removes approximately 65 percent of the suspended solids and 35 percent of the oxygen-demanding organic materials from incoming wastewater.

The fifth Metro plant at Renton presently provides secondary treatment, which removes over 85 percent of the solids and oxygen-demanding materials by settling and controlled bacterial decomposition, before discharging treated wastewater to the Green-Duwamish River. The Renton plant is not considered in the Facility Plan, except as it is affected by alternative actions for the Puget Sound plants.

Collection System

The existing collection system transports wastewater (sewage) to the plants for treatment and disposal. As a result of the collection system design and local rainfall patterns, a major portion of the system transports storm water as well as sewage. During dry weather, flow is comprised principally of sewage. During wet weather, infiltration of groundwater and inflow from storm drains into portions of the collection system result in combined sewage and storm flows. The sewers that transport both sewage and storm flows are called combined sewers.

Flows during wet weather periods exceed the carrying capacity of the collection system, causing combined sewers to overflow into Lake Washington, Portage Bay, Lake Union, the Ship Canal, the Duwamish River, Elliott Bay and Puget Sound. For further details on combined sewer overflows (CSO's), reference is made to Chapter IV of the Draft Facility Plan plus Chapters II and III of this EIS.

To reduce the frequency and volume of overflows, Metro employs a computer controlled storage and diversion system for its wastewater flow during wet weather conditions. The system reduces the number of combined sewer overflow occurences and can divert flows from one location to another.

Sludge Management

Metro also handles sludge, which is the solid material that settles at the plants during the sewage treatment process. After it is removed from wastewater, sludge is processed by digestion to stabilize it. Subsequent dewatering can be used to reduce the sludge volume before it is transported to a land site.

Currently, the West Point plant functions as the regional sludge processing center for the majority of the Metro service area. It treats digested sludge from Richmond Beach and Carkeek Park, raw sludge from Renton, plus solids from incoming wastewater for the West Point service area. Sludge at West Point is digested, dewatered and trucked to the Cedar Hills landfill for disposal and an experimental reforestation site in the Pack Forest for recycling. Alki sludge is digested on-site, then hauled to the Cedar Hills landfill for disposal.

WATER QUALITY PLANNING AND REGULATIONS

The concern over water quality protection and improvement has been manifested in several key events that have affected wastewater facilities in the metropolitan Seattle area. Actions have been influenced by local goals and policies, state requirements, and national legislation. Recent local planning and current federal requirements are summarized in this section.

Recent Local Planning

The Municipality of Metropolitan Seattle (Metro) was formed in September 1958 in response to citizen concern over water quality problems in the Lake Washington drainage basin. In 1957, citizens were instrumental in securing passage of a bill in the Washington State legislature which enabled the formation of metropolitan municipal corporations to handle water pollution and other area-wide problems. Such a corporation was established in the Seattle metropolitan area by a popular vote in 1958. That election created Metro and assigned it the power to prepare a comprehensive sewage plan, acquire or construct facilities, operate facilities, and set rates. The subsequent formation of the Metro Council was followed by its first major action: adoption of a comprehensive plan for sewage disposal within a 230 square mile area in the Cedar and Green River Basins. This plan was initiated by the City, County and State before Metro was formed, and completed and adopted by Metro in 1958.

The Comprehensive Plan established a network of interceptor sewers and regional wastewater treatment facilities to replace numerous local plants. The focus of the plan was toward consolidation of wastewater facilities to a small number of regional plants and transfer of treated wastewater discharge from fresh to salt water. The program included staged facilities development to meet projected population growth. During the first ten years, approximately $120 million worth of collection, treatment and disposal facilities were constructed. The regional treatment plants included four primary treatment facilities discharging to Puget Sound: West Point (1966), Alki (1958), Carkeek Park (1962), and Richmond Beach (1962). In addition, an inland plant with secondary treatment was constructed at Renton (1965). By 1970, most of the raw sewage discharge to the Duwamish River, Elliott Bay and Puget Sound had been eliminated. Since the Metro facilities have been in operation, substantial water quality improvements have occurred in Lake Washington and nearshore marine waters.

A second major planning effort by Metro further refined water resources planning on a regional basis but emphasized prevention rather than treatment. In response to the Federal Water Pollution Control Act of 1964 (as amended), Metro and King County prepared a plan for the Cedar and Green River basins, which was overseen by the River Basin Coordinating Committee (RIBCO), appointed by Metro Council. Major studies were on water quality management, water resources management, urban runoff and basin drainage, and solid waste management. The resulting RIBCO plan affirmed the conclusion of the Metro Comprehensive Plan and recommended regional sewage treatment facilities served by interceptor networks.

Current Federal Planning Requirements

The 1972 amendments to the Federal Water Pollution Control Act (Public Law 92-500 or PL 92-500) marked the beginning of more substantial federal involvement in wastewater facilities planning and construction, water quality requirements and implementation procedures. According to Section 101 of PL 92-500, the national goals for water quality are (1) elimination of pollutant discharge into navigable waters by 1985 and (2) an interim goal, wherever attainable, of water quality suitable for fish, shellfish, wildlife, and recreation by July 1, 1983 (often abridged as the "fishable/swimmable" goal). Implementation of the PL 92-500 goals involves various planning provisions and discharge requirements.

Planning requirements are prescribed under Sections 201, 208 and 303 (e) of the Federal Act. Section 201 plans, known as facilities plans, consider alternatives for individual wastewater treatment plants, such as service areas, collection systems, treatment processes and sludge disposal. If facilities are judged to be major federal actions significantly affecting the quality of the human environment, an EIS is required before approval. If the plan and EIS are approved, Section 201 also allots federal funding for facilities design and construction. The Metro Draft Facility Plan (Metropolitan Engineers, 1977) and this EIS series represent response by Metro, the Washington State Department of Ecology (DOE) and the United States Environmental Protection Agency (EPA) to the Section 201 planning requirement of PL 92-500.

Concurrently, Metro is preparing an area-wide waste treatment management plan, under Section 208 of PL 92-500, which addresses both point (municipal and industrial) and non-point (agricultural and urban runoff) sources of pollutant discharge. The previously described RIBCO project, also prepared under Metro, satisfies the river basin planning requirement for water resources under Section 303 (e) of the Act.

The planning requirements for meeting the water quality goals of PL 92-500 are supplemented by specific effluent or discharge requirements. For publicly owned treatment works, such as Metro's five wastewater treatment plants, Section 301 of the law specifies that secondary treatment must be provided by July 1, 1977. Best practicable treatment (BPT) is required by 1983. Specific discharge requirements for each facility are contained in National Pollutant Discharge Elimination System (NPDES) permits, issued in Washington by the DOE as the designated representative for EPA.

Because the law requires secondary treatment for municipal wastewater treatment plants, EPA will only provide construction grant funds for alternatives which meet secondary treatment requirements. Currently, these grants under PL 92-500 are funded 75 percent by the EPA for eligible projects. DOE provides 15 percent of construction costs, and Metro would fund the remaining 10 percent. However, for alternatives that do not include secondary treatment, the provisions of PL 92-500 would not allow federal or state funding.

REGIONAL ISSUES

Several regional issues related to alternative wastewater facilities have formed an integral part of the EIS. Some issues were identified jointly by the EPA, DOE and Metro in an initial Memorandum of Understanding prior to preparation of the EIS. Other issues were identified by the facilities planning, socio-economic, architectural or EIS consultants. Public input into the planning process has generated some additional issues.

The major regional issues generally can be grouped into categories as follows: (1) legal and institutional consideration, (2) water quality, (3) plant siting, (4) sludge, (5) growth, and others. Issues of particular concern to individual sites, such as odor or visual impacts, are addressed in the site documents, Volume II of the EIS.

Legal and Institutional Considerations

Several legal and/or institutional factors are issues in the development of alternative wastewater facilities and in analysis of their impacts. Among these are national, state, or local regulations of water quality, shoreline management and others.

Water Quality

Water quality regulations pursuant to PL 92-500 specify two types of standards: (1) effluent quality and (2) receiving water quality. The first provision requires effluent or treated wastewater to meet the quality typical of secondary treatment processes by 1977; effluent quality from best practicable treatment is required by 1983. The second provision is a goal that receiving waters (such as Puget Sound), to which effluent is discharged, would meet fishable/swimmable quality by 1983. Under the law, both factors apply to the Metro area.

The Draft Facility Plan contains alternatives that were focused on various combinations of effluent quality and receiving water quality goals. For example, four of the alternatives contain secondary treatment in compliance with the effluent quality regulation. Other alternatives were developed in response to the Metro strategy, a position developed by Metro in 1973. At that time, available scientific evidence led Metro to conclude that secondary treatment would not produce water quality benefits commensurate with costs. Therefore, other options for improving local water quality were explored in an attempt to achieve the fishable/swimmable goals. One method proposed by Metro for local water quality improvement would be control of combined sewer overflows; thus two of the alternatives include combined sewer overflow control measures.

Background

However, only those alternatives (described in detail in Chapter III) that include secondary treatment comply with PL 92-500. Other alternatives that contain combined sewer flow control but not secondary treatment are currently ineligible for EPA funding for construction. Thus, the legality and fundability of alternatives under PL 92-500 and consequences thereof are considered in the EIS (Chapters II and III). The legality of alternatives appeared to be an important issue at public meetings. In fact, many suggested that illegal alternatives should not be considered.

The relationship between various water quality planning elements of PL 92-500 has also been an important consideration in the Facility Plan and EIS. For example, the Facility Plan (developed in response to Section 201 of PL 92-500), the Areawide Waste Treatment Management Plan (pursuant to Section 208 of PL 92-500) and the RIBCO Basin Plan (based on Section 303e requirements of PL 92-500) have been considered to the extent possible in the EIS. As expressed at public workshops, the interrelationship of water quality planning, particularly the Section 201 and 208 plan, is an important public concern.

Other Requirements

The relationship between water quality goals and other governmental goals was also examined in evaluating alternatives. For example, local shoreline management policies that seek to control construction along shorelines and recreational planning that aims at providing improved public access are considered in the EIS. Other statutory requirements are sometimes contradictory to water quality requirements, particularly as they affect plant size and site. These potential conflicts are discussed in more detail in Chapters II and III.

Water Quality

Because the wastewater Facility Plan is based on both local and national goals for water quality protection and improvement, water quality is a central issue in the Plan and EIS. The effect of present effluent discharge, future discharges, and combined sewer overflows on water quality are evaluated in the EIS. Most of this discussion is in the Regional EIS.

Effects of Present Treatment Plant Discharges to Puget Sound

The question of the effects of the present treatment plant discharges to Puget Sound is central to the analysis of existing and future impacts on water quality and subsequent effects on biology and public health. Studies have recently been completed that indicate that Metro's discharge is not causing substantial degradation to the water quality in the Sound. However, there is some disagreement within the scientific community as to the interpretation of the data that is available on water quality, particularly in terms of dissolved oxygen, nutrients, and flushing rates. More information on the existing water quality is described in Chapter II.

Puget Sound is a complex water system that is influenced by pollutant discharges not only from Metro's four wastewater plants, but also from nine other municipal discharges, combined sewer overflows, industrial discharges, non-point pollution sources (urban runoff, agricultural and forest-related runoff) and aerial fallout. Given this situation, it is not a simple matter to measure directly the impacts from Metro's treatment plants. The Puget Sound Interim Studies, funded by Metro and now nearing completion, have researched several aspects of Puget Sound water quality and biological conditions and have arrived at preliminary conclusions, based on two years of scientific study. This EIS is also charged with independently synthesizing and analyzing existing information and estimating the effects of present and projected discharges to Puget Sound. Information and conclusions to date on this issue are presented in Chapters II and III of this EIS, but more research is necessary to definitively answer the questions.

The EIS has considered other water quality impacts, particularly possible subtle, long-term impacts of toxic materials such as heavy metals, chlorine, or chlorinated organic compounds. Since Puget Sound is important for both commercial and sport fishing, any adverse impacts of water quality on fish and shellfish are important issues for evaluating wastewater management alternatives. Public health risks are also analyzed because wastewater discharged to the Sound could potentially degrade water quality at recreational beaches or contaminate fish or shellfish later ingested by humans.

Background

Effects of Future Discharges

The impacts of future discharges to Puget Sound and/or other water bodies are considered in Chapter III of the EIS, following the description of existing conditions. For every alternative, the projected impacts are evaluated with respect to variations in wastewater volume, treated water quality, and discharge site. Since the wastewater Facility Plan addresses the issue of treatment processes, the EIS evaluates impacts from discharging effluent from primary, enhanced primary, secondary, or advanced waste treatment plants. In addition to the effects of alternative treatment processes on water quality plus related areas of biology, fishing, recreation and public health, the EIS also investigates the effect of each process on costs, employment, sludge, plant sites, legal and institutional concerns, and other factors.

Impacts of Combined Sewer Overflows (CSO's)

The frequency and volume of combined sewer overflows (CSO's) in the metropolitan Seattle area have led to concern over their impacts on water quality and subsequently on fisheries and public health. Presently, CSO's discharge intermittently to Lake Washington, Lake Union, the Ship Canal, the Duwamish River and estuary, other freshwater bodies, Elliott Bay and Puget Sound. Although the impacts of CSO's on fresh and marine waters have only recently been investigated by Metro, it is possible that the uncontrolled discharge of combined storm water and sewage and their associated bacteria, nutrients and toxicants could have adverse effects on fish, shellfish and recreational areas.

Sludge

Management of sludge, the solid material removed in wastewater treatment, has been identified by Metro, DOE, EPA, and the public as an important regional issue. Therefore, sludge was considered in the Facility Plan and EIS. The amount of sludge production is linked to the treatment process (primary, enhanced primary, secondary) and wastewater volume of various alternatives. The effects of sludge volume and concentration from alternative wastewater treatment processes are described in the EIS. Possible regional impacts of sludge handling and disposal include energy use for sludge processing and transportation; effects at a land disposal site such as groundwater contamination, alterations in topography, changes in soil characteristics; recycling benefits and costs; and public health risks. Traffic associated with sludge transport from production site to disposal site may be an important factor in evaluating alternatives. On a regional basis, the location of sludge treatment and disposal sites requires careful consideration since the possibilities for disposal or re-use may be affected.

The present Facility Plan contains an interim solution for sludge disposal that is common to all alternatives: disposal at an existing land fill. Experimentation with incineration, pyrolysis, agricultural and park use, land reclamation and reforestation techniques for sludge re-use will be continued. Various configurations of sludge processing facilities are contained in the Facility Plan alternatives. Other sludge processing or disposal alternatives were evaluated on a preliminary basis in the facilities planning work, but were eliminated for various reasons, at least on an interim basis. Therefore, the EIS only evaluates a single sludge disposal alternative with its various options for processing. Since the sludge handling and disposal method is an interim solution for an important regional issue, future planning on sludge treatment and environmental analysis of sludge-related impacts is necessary.

Plant Location

The location of treatment plant sites has received considerable attention in the facilities planning process and in meetings with local citizens. Since alternatives include options for maintaining, expanding, upgrading or abandoning existing plant sites and constructing new ones, the issue is a visible one, particularly among residents living near existing sites. In addition to potential site-specific impacts on land use, odor, nuisance, traffic, views and related topics, there are regional or systemwide issues on plant siting. These involve policies on shoreline management and access, compatibility with regional land use and recreational opportunities, impacts on the local tax base and others. The options of a few large plants versus many small plants raise issues of centralization versus decentralization, with attendant impacts on local control, growth patterns, quality control, economics of scale, and potential for effluent or sludge reclamation and re-use.

Growth

Growth, as related to wastewater management alternatives, was identified by EPA, DOE and Metro as a key regional issue for the EIS. Subsequently, other agencies and the public have mentioned the importance of considering growth.

The location and staging of wastewater collection systems can, along with provisions of other infrastructure, influence growth patterns in a region. The link between population growth and impacts on land use, air quality, water quality and related topics is typically described in EIS documents.

Under the present Draft Facility Plan, the issue of growth is less of a factor in distinguishing among alternatives and impacts than it is in some EIS's. This relates to the fact that the existing Metro treatment plants of West Point, Alki, Carkeek Park and Richmond Beach already have the capacity to handle projected dry weather flows for their current service areas until the year 2005. Thus, most of the discussion on alternatives is based on alternative treatment processes rather than on alternative future capacities.

In addition, the study area and alternatives in the Draft Facility Plan are limited to approximately the service areas of the four plants that presently discharge to Puget Sound. Alternative sites within these service areas are also considered. However, the Renton plant and service area, where much of the area where future growth could be expected to occur, is not considered as part of the alternatives in the Facility Plan. Instead, the effects of various alternatives on Renton site are shown for illustration but are not included in the proposal.

Interceptors (large wastewater collection sewers) to service new growth areas are not presently included in the Draft Facility Plan. Instead, future interceptors to serve new growth areas would be considered separately as they are proposed by a local agency to Metro.

Therefore, although the EIS recognizes that growth is an important issue, it can only address specific growth impacts as related to proposed treatment plant alternatives. For example, if an alternative includes a change in service area or growth that would cause more combined sewer overflows, the effects of these combined sewer overflows are examined. In addition, the EIS contains an analysis of generalized growth impacts on a regional level in Chapter III.

CHAPTER II

EXISTING ENVIRONMENTAL CONDITIONS

The Metro study area, dominated by the City of Seattle, is part of the Central Puget Sound region of Northwest Washington (Figure 2-1). This study area contains 575 square miles, including portions of western King County and southwestern Snohomish County to the north. The Metro area lies in the Green and Cedar River basins which are tributaries to Puget Sound.

The Puget Sound region lies between two north-south trending longitudinal ranges of glacier-capped mountains: the Olympics to the west and the Cascades to the east. Coniferous forest characterizes the lower elevations. Classic cone-shaped volcanoes, some of which are still active, form striking landmarks in the area.

A marine climate and heavy rainfall have produced lush vegetation and abundant rivers and streams. Human activity is concentrated primarily in the coastal and alluvial valleys where timber clearing has replaced the conifers with maples and other deciduous trees. Puget Sound affords access to the Pacific Ocean and extensive protected beaches and harbors. Lake Washington and Lake Sammamish, to the east of Puget Sound, are the largest freshwater bodies in the area, although small lakes, ponds and streams abound throughout. The region's natural resources include timber, fish, shellfish and other marine resources. Additional major economic bases today are Boeing Aircraft and tourism, the latter primarily a result of the Seattle World's Fair in 1962.

For analytical purposes, further discussion of the environmental setting is subdivided into the physical, biological, and human environments. It is clearly understood that the three overlap, but this artificial division ensures a thorough analysis of relevant impacts.

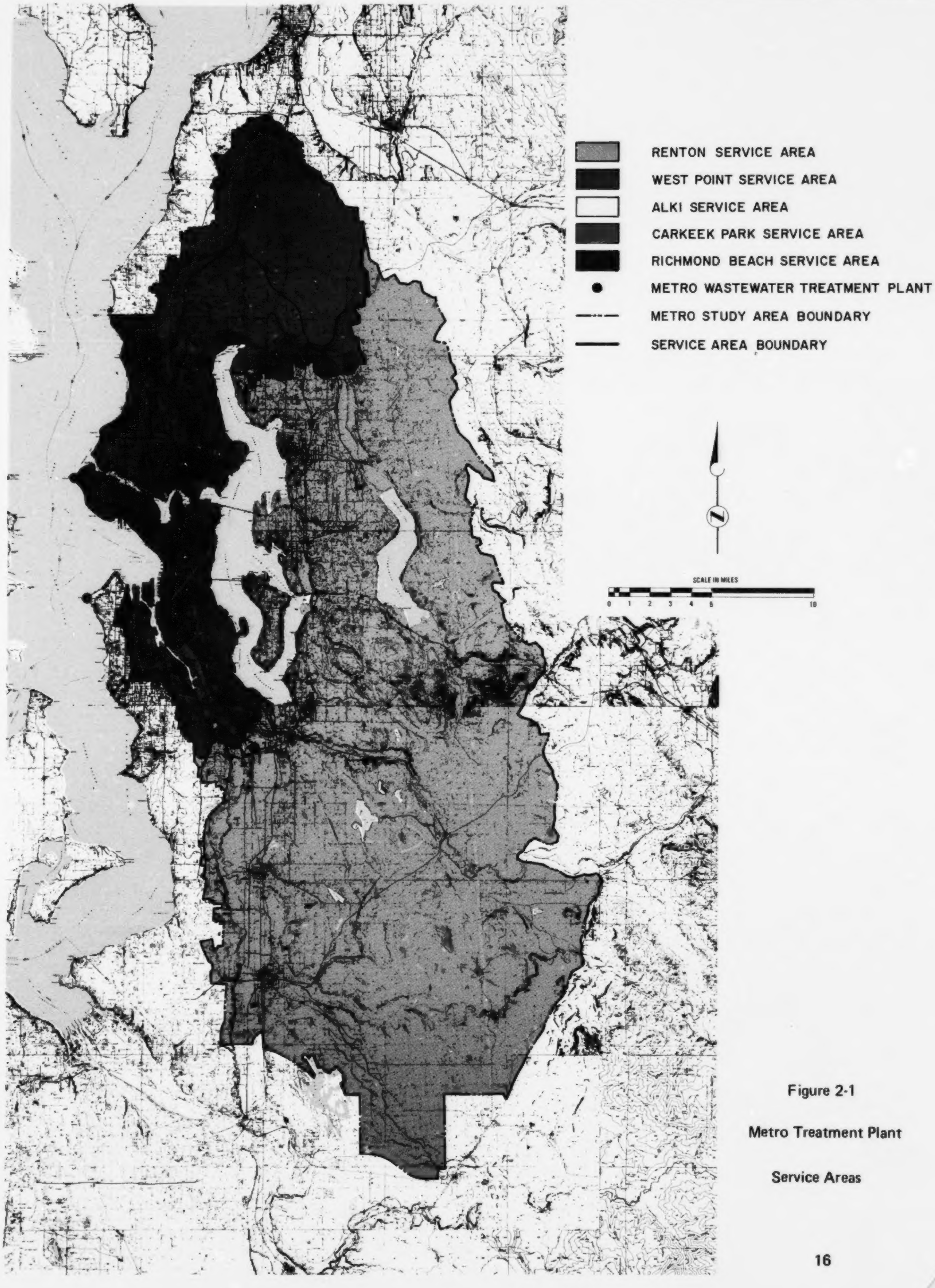

RENTON SERVICE AREA
WEST POINT SERVICE AREA
ALKI SERVICE AREA
CARKEEK PARK SERVICE AREA
RICHMOND BEACH SERVICE AREA
METRO WASTEWATER TREATMENT PLANT
METRO STUDY AREA BOUNDARY
SERVICE AREA BOUNDARY
N
SCALE IN MILES
0
1
2
3
4
5
10

Figure 2-1

Metro Treatment Plant

Service Areas

Existing Environmental Conditions

PHYSICAL ENVIRONMENT

The physical environment discussion describes the character of the land, the water supply, the wastewaters and natural waters affected by those wastewaters, and atmospheric aspects including climate and air quality.

Topography

Topography has influenced the location, design, construction, cost and operation of regional sewerage and drainage facilities. The boundaries of sewerage service areas and the present study area have been determined by watersheds, a function of topography, rather than political decisions. As a result, the Metro area extends from Silver Lake to the north to Auburn on the south, and from Puget Sound eastward for up to 18 miles. Topography has also helped to determine wastewater treatment and disposal sites; the size, route and slope of collection sewers and the areas tributary to them; the necessity for and location of pump stations; and population distribution and growth.

The topography of the study area is characterized by striated hills, rolling glaciated uplands and deeply incised adjoining troughs. Principal physical features generally have a north-south trend like that of Puget Sound, Lakes Washington and Sammamish, stream valleys and the intervening ridges. Elevations in the study area range from 14,000 feet at Mount Rainier to sea level. The average elevation in Seattle is about 200 feet, as shown in Figure 2-2.

Geology and Soils

Regional and local geology is relevant to planning of sewerage works in that conditions encountered in the construction of pipelines, tunnels and other structures affect design and construction requirements and thus have a direct bearing on cost. Geological conditions may be determining factors in choosing routes of principal sewers and may influence the overall scheme of sewerage. Moreover, soil formations, both surface and subsurface, determine the feasibility of local sewage disposal (by means of septic tanks and leaching fields) and the magnitude of seismic hazards. Groundwater location, landslide zones and seismicity also influence facilities location and the impact of natural forces upon them.

The Metro study area geology and soils were developed through various geologic processes, including the action of glaciers, which left deposits of fill, and scoured out the Puget Sound. Lakes formed in depressions left by the melting of buried ice. Erosional processes occurred after the upthrust of the Cascades and formed the Cedar and Green River basins.

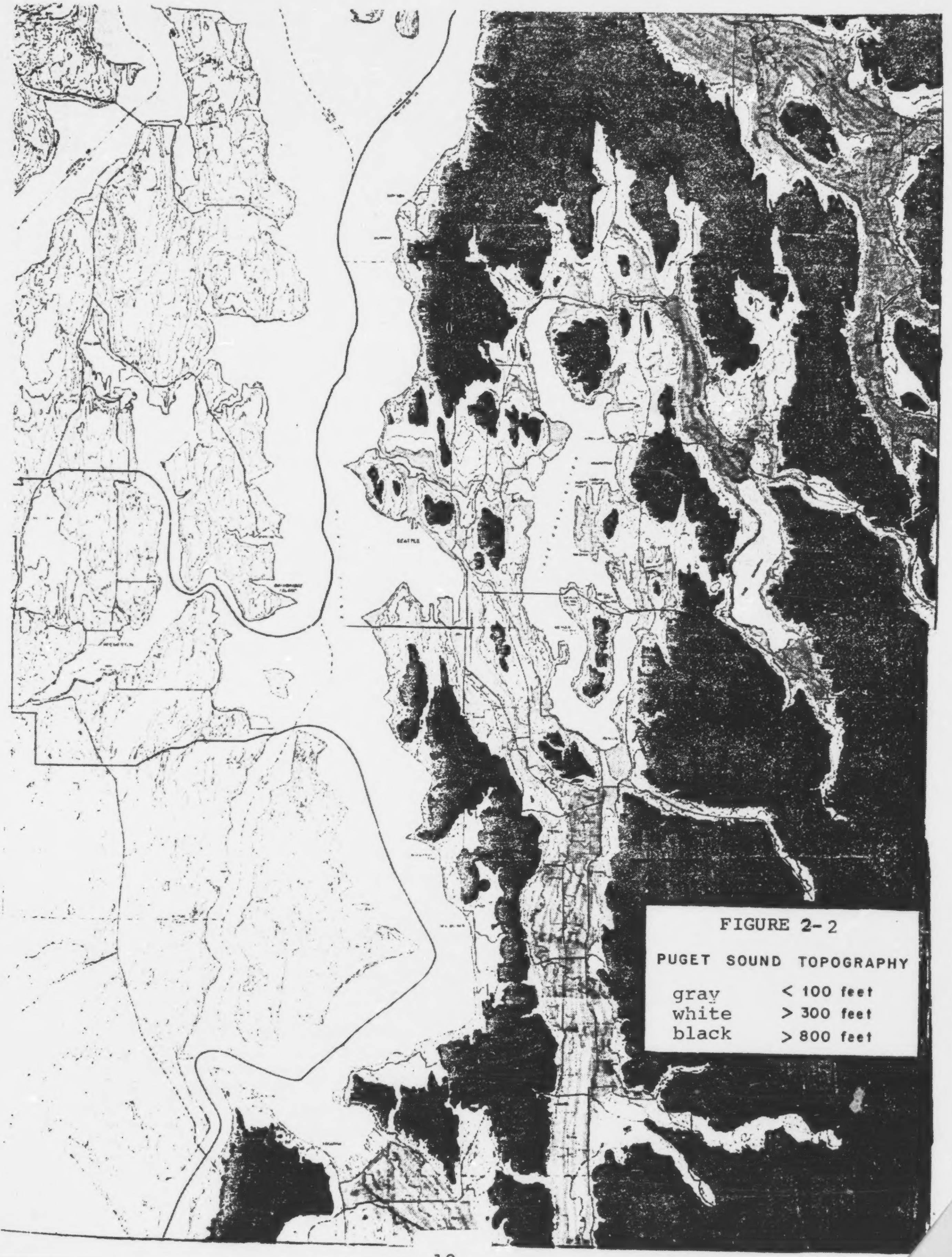


FIGURE 2-2

PUGET SOUND TOPOGRAPHY

gray	< 100 feet
white	> 300 feet
black	> 800 feet

Alluvial deposits of post-glacial age formed as valley floors. Regional geologic features are summarized in Figure 2-3. Soils in the Metro study area include three general types: firm dry clays and silts, hard cemented till, and waterbearing sands and gravels. Soil characteristics were considered in the development of wastewater facilities since they affect bearing capacities for structures, bedding conditions for pipelines, groundwater table, landslide potential, seismic role and other factors. In general, the land and terrace soils of loamy fine sand, gravelly or stony material are often underlain by cemented till and provide good structural support. Lowland soils are composed of sandy or silty alluvium. These have good bearing capacities.

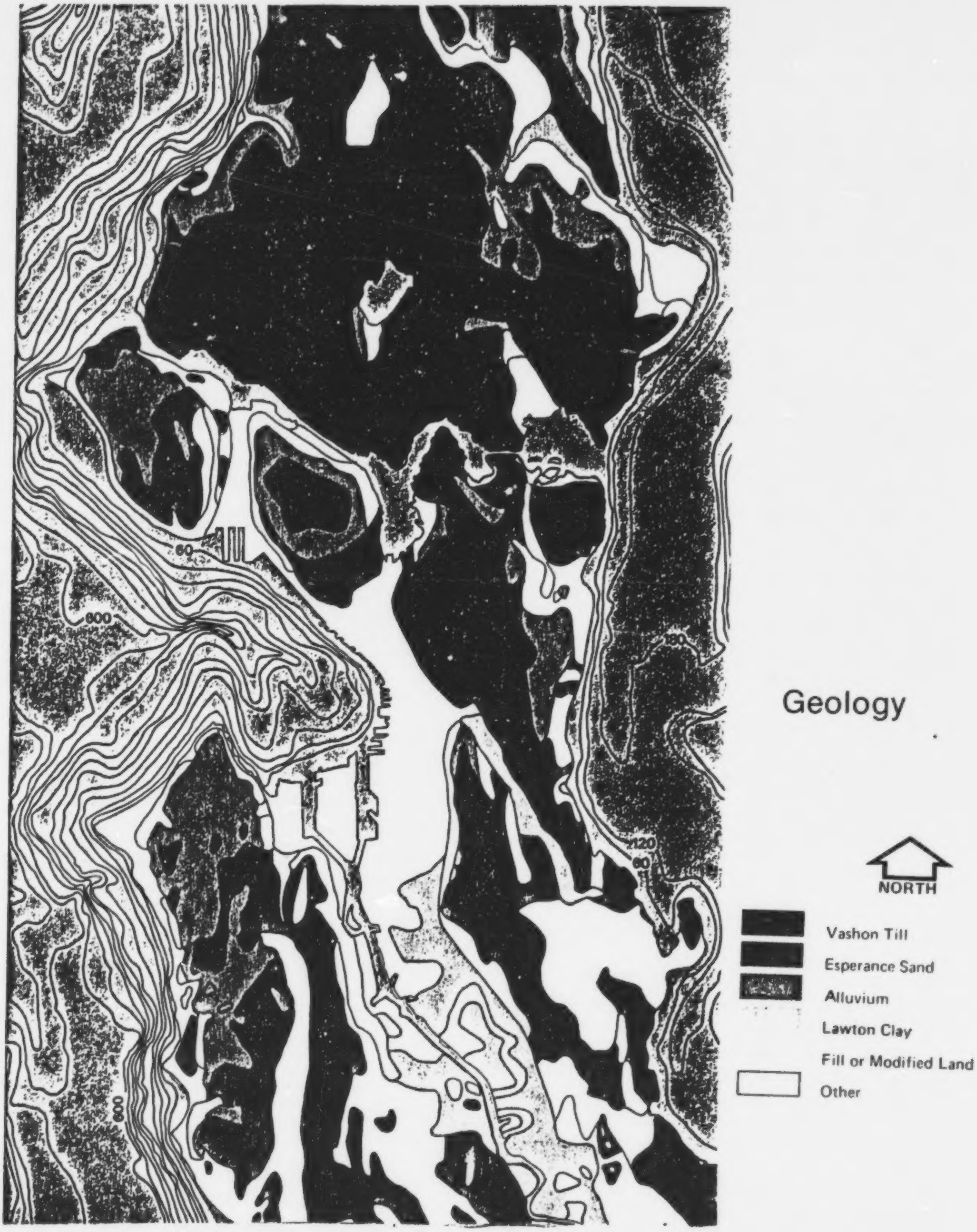
Peat deposits that occur along some water courses and tidelands require special beddings for pipelines or structures. Figure 2-4 describes these soils.

Groundwater occurs primarily in low-lying, permeable soils. A few high-discharge wells are present in the uplands, but predominately, this region is characterized by impervious compact glacial till. In the lowlands there are a few peat deposits up to 12 feet thick which contain groundwater tables. Sewage lines passing through these areas may experience infiltration problems.

Hazardous landslide zones and landslide deposits in the study area are shown in Figure 2-5 (McGreevy, 1973). These occur mainly along the beach and on the fringe of basins. Landslide zones reflect two basic causes: (1) wave action eroding the base of the cliffs, and (2) collapse of hills following saturation and loss of strength in sandy soils.

In terms of seismicity, the study area has been classified as zone 3 - the highest rating of seismic activity in the United States (PSCOG, 1975). Major quakes in 1949 and 1965 caused loss of life and major property damage in western Washington and northeastern Oregon (Rasmussen, 1967; Algermessen, 1966; U.S.G.S., 1975). Damage was primarily to older, poorly constructed brick buildings; to the Duwamish industrial area situated on unstable fill materials; and to areas such as West Seattle that are underlain by compacted sediments which transmit vibrations. Characteristics of selected major quakes in the area have been summarized (Rasmussen et al., 1974).

Seismic design considerations are based on the Uniform Building Code, which indicates that structures in the Puget Sound area should be designed to withstand a "zone 3" earthquake, ground shaking able to cause major damage, registering VIII or greater on the Modified Mercalli Scale. The most likely Metro-related damage would be to collection system elements


60
600
180
120
60
600
Geology
NORTH
Vashon Till
Esperance Sand
Alluvium
Lawton Clay
Fill or Modified Land
Other

Source: McGreevy, 1973

Figure 2- 3

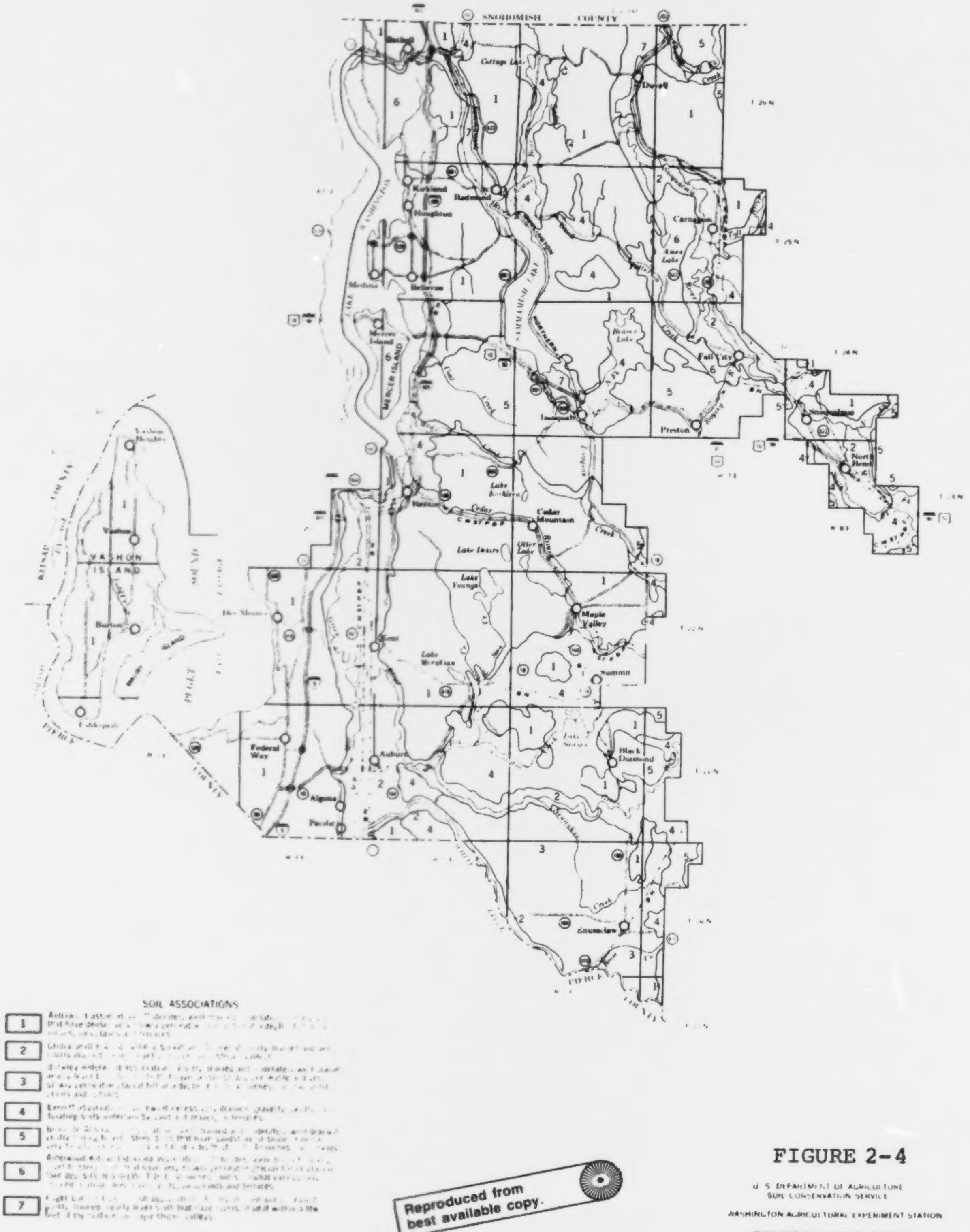

SNOHOMISH COUNTY
Bothell
Cottage Lake
Duvall
Creek
Kirkland
Redmond
Houghton
Carnation
Ames Lake
Medina
Bellevue
LAKE WASHINGTON
SAMMAMISH LAKE
Mercer Island
MERCER ISLAND
Beaver Lake
Fall City
Issaquah
Preston
Snoqualmie
North Bend
Vashon Heights
Vashon
VASHON ISLAND
Burton
Tahlequah
PUGET SOUND
Des Moines
Renton
Lake Kathleen
Cedar
Cedar Mountain
Lake Desire
Otter Lake
Lake Youngs
Maple Valley
Kent
Lake Meridian
Summit
Federal Way
Auburn
Algona
Pacific
Black Diamond
Enumclaw
PIERCE COUNTY
SOIL ASSOCIATIONS
1
2
3
4
5
6
7

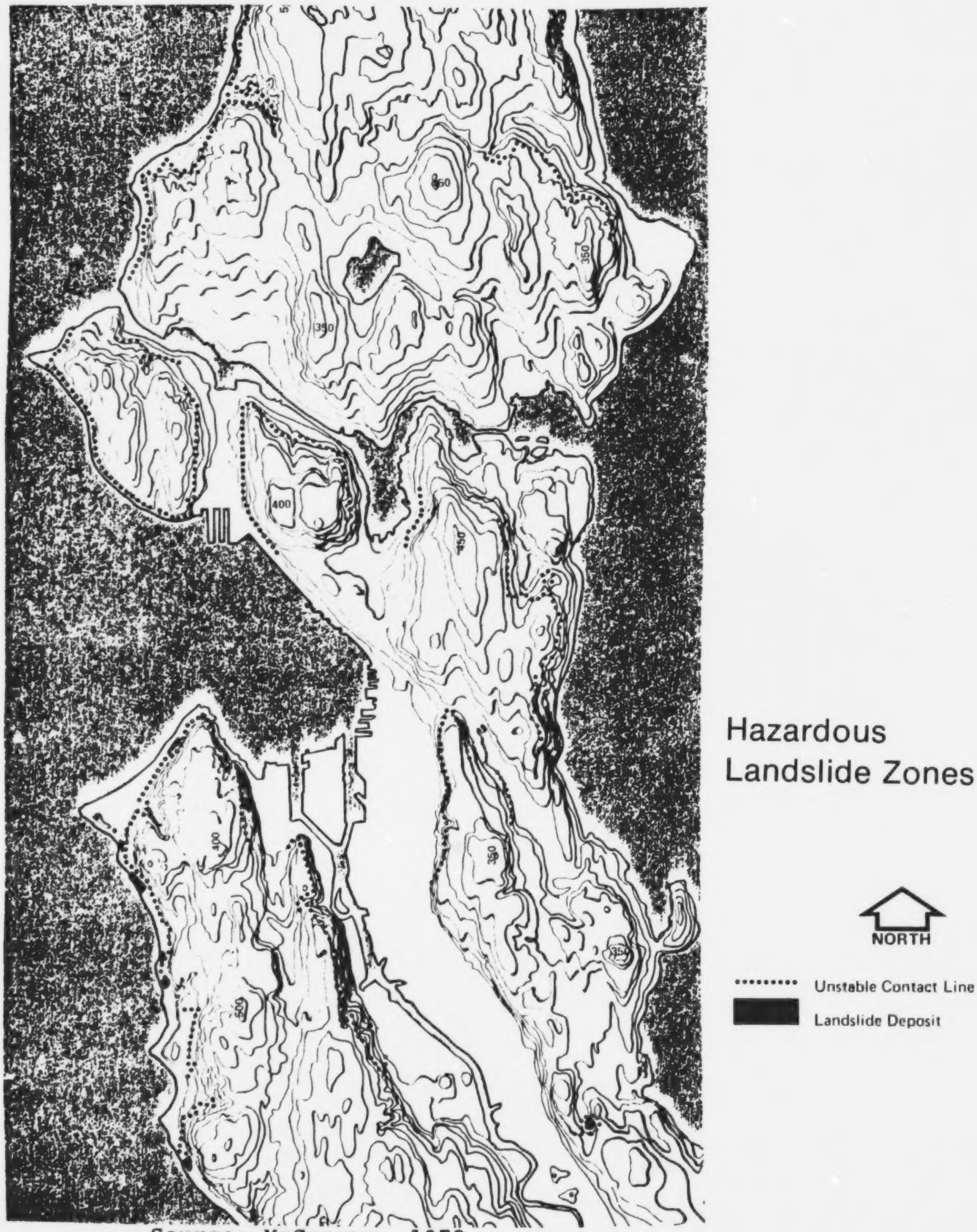
FIGURE 2-4

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

WASHINGTON AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP
KING COUNTY AREA, WASHINGTON

Reproduced from best available copy.


Hazardous
Landslide Zones
NORTH
Unstable Contact Line
▬ Landslide Deposit
450
350
350
400
450
400
350
350

Source: McGreevy, 1973

FIGURE 2- 5

which cross fault lines. The magnitude of potential earthquake hazard risk for a specific area in the Puget Sound region is difficult to ascertain, as thick glacial deposits mask the underlying bedrock. Faults were apparently detected by oil explorations, but their locations have not been made generally available (Norman Rasmussen, personal communication).

For more detail on regional geology, soils, groundwater location, landslide zones, and seismicity, the reader is referred to the facilities planning documents and task reports (Metropolitan Engineers, 1977). Site-specific information is contained in Volume II of the EIS series.

Climate

The Puget Sound region has a temperate marine type climate characterized by rainy and rather mild winters and relatively dry and cool summers. Average daily temperatures typically are below 70°F in the summer and above 40° in winter.

The Puget Sound area is flanked on the west by the Olympics, which rise from 4,000 to 8,000 feet and protect the Metro area from severe winter storms moving inland. To the east of the Metro area, the Cascades cause air masses to rise, cool, and precipitate. These mountain ranges also tend to channel the major wind systems into a general north-south direction. Snowfall ranges from 10 to 30 inches in the lowlands, 75 to 100 inches in the foothills, and 300 to 500 inches in the mountains which feed Cedar and Green Rivers. Average annual rainfall is 35 to 50 inches occurring over about 162 days a year.

Inversions and fogs are common in the Puget Sound area. Horizontal mixing is good in the area near the Sound, but inland areas, especially low lying valleys, have a greater tendency to trap air masses.

For more extensive data on climate in the Puget Sound region, the reader is referred to Facility Planning Task D3 (Metropolitan Engineers, 1976).

Air Quality

Emissions from King County for 1973 are presented in Table 2-1 (PSAPCA, 1973). Motor vehicles are responsible for the major emissions of nitrogen oxides, hydrocarbons and carbon monoxide, while industrial sources account for most of the sulphur dioxide. Autos emit a little over half of the total suspended particulates but are far more diffuse sources than industrial stationary sources.

TABLE 2-1

SUMMARY OF 1973 AIR CONTAMINANT EMISSIONS IN KING COUNTY

Air Contaminant Source	Suspended Particulates	Sulfur Dioxide	Nitrogen Oxides	Hydro-carbons	Carbon Monoxide
Fuel Combustion					
Residential Area					
Bituminous Coal	35	40	5	35	158
Distillate Oil	441	1649	530	132	221
Natural Gas	143	5	375	60	150
Wood	107	1	13	75	314
Other	5	0	18	2	5
	731	1695	941	304	848
Commercial, Institutional, Industrial					
Bituminous Coal - Area	0	0	0	0	0
- Point	0	0	0	0	0
Coke - Point	0	0	0	0	0
Distillate Oil - Area	610	1625	2928	122	163
- Point	43	118	206	9	11
Residual Oil - Area	624	5834	1953	82	108
- Point	113	1031	355	15	20
Natural Gas - Area	101	3	642	23	98
- Point	175	6	1563	30	166
Processed Gas - Point	0	0	0	0	0
Wood - Area	0	0	0	0	0
- Point	1275	16	1566	313	313
Other - Area	2	0	11	1	2
- Point	1	0	5	0	1
	2944	8633	9229	595	882
Stationary Electrical Power Plant	46	1067	609	12	17
Subtotal	3721	11395	10779	911	1747
Process Losses					
Area	393	0	1	11510	4
Point	3930	2218	113	5920	427
Subtotal	4323	2218	114	17430	431
Solid Waste Disposal					
Incineration					
On-Site - Area	16	8	17	12	38
- Point	36	0	5	29	338
Municipal - Point	0	0	0	0	0
Open Burnings					
On-Site - Area	365	1	17	175	1227
- Point	0	0	0	0	0
Dumps - Area	0	0	0	0	0
- Point	0	0	0	0	0
Slash Burning - Area	284	2	33	334	836
Subtotal	701	11	72	550	2439
Transportation - Area					
Motor Vehicles					
Gasoline	3992	969	34675	55436	321441
Diesel	65	122	1356	224	1299
Off-Highway Usage	103	43	377	5663	20479
Aircraft	85	120	966	2126	5770
Railroad	183	272	547	365	512
Vessels	216	1096	737	360	488
Evaporation Losses	0	0	0	5572	0
Liquid Petroleum Gas	0	0	40	18	104
Subtotal	4644	2622	38698	69764	350093
Miscellaneous Area Sources					
Orchard Heating	0	0	0	0	0
Agricultural Burning	0	0	0	0	0
Wild Fire	129	1	15	152	380
Subtotal	129	1	15	152	380
Totals					
Subtotal - Area	7615	11789	45223	82145	352961
Subtotal - Point	5903	4458	4455	6662	2129
Total Emissions (tons/year)	13518	16247	49678	88807	355090

Source: PSAPCA data, 1973.

Existing Environmental Conditions

Most air quality parameters are below the primary federal standards, but some do violate the more restrictive Washington State and Puget Sound standards.

The subsidence inversions common to the autumn in the Puget Sound region are associated with highest levels of pollutants, especially if accompanied by low northerly windspeeds. The Duwamish Valley, a topographic subbasin, develops inversions, and low wind conditions. Before siting sewage treatment facilities in this or other inversion-prone valleys, one should consider existing air pollution problems.

Sewerage Facilities Emissions

Potential treatment plant emissions include aerosols containing pathogenic microorganisms and gases including chlorine, ammonia, methane, carbon monoxide, hydrogen sulfide, carbon disulfide, mercaptans, hydrocarbons, and protein decomposition products, many of which are odoriferous. These odors can usually be traced to three sources: septic raw wastewater (contains no dissolved oxygen), overloaded facilities, and sludge treatment practices.

Primary treatment facilities can produce odors, particularly if the settling basins are uncovered or if the incoming sewage contains no dissolved oxygen (as a result of long travel times in the collection system). Secondary treatment offers more area for contact between wastewater and air, so the potential for odors can increase, particularly if the plant is overloaded. Because the volumes of odors emitted from sewage treatment processes are small, the probability of odors being detected beyond one-half mile from a treatment plant is slight.

Techniques for controlling, minimizing, or preventing odors from being generated or dissipated include chemical wastewater treatment, prevention of uncontrolled septic or anaerobic condition, and confinement of odors. In sewer lines, oxidizing agents such as chlorine, hydrogen peroxide, and permanganate compounds are often used against hydrogen sulfide gas emissions.

Data on air pollutants generated by Metro sewerage facilities are limited as few problems have been identified. Waste digester gas is flared; other potential emissions are from boilers and gas-fired engines (Metropolitan Engineers, 1976).

Complaints of odor from the Alki treatment plant received by PSAPCA were transmitted to Metro in the summer of 1976.

Numerous complaints on odors at Alki have been reiterated in public workshops. Metro has attempted to control odor at Alki by increasing chlorination, modifying the waste gas burner, adjusting the boiler and improving plant housekeeping. However, odor remains a problem at Alki and also at times at Carkeek Park as is specified in site-specific documents.

Manholes, pumping stations, regulators, holding tanks, and siphons are all potential odor sources. Hypochlorite scrubbers have been installed on the wet well exhaust of several pumping stations within the Metro sewerage system for odor control. Flushing sewer lines with water is becoming standard practice for combating H_2S production by diluting, oxygenating, and promoting scouring.

Water Resources

Water resources play a prominent role in the Seattle metropolitan area. Commercial trade uses the international harbor; a substantial ferry system interconnects Puget Sound's communities; many of the industries are water dependent; and weekend recreation includes salmon fishing, swimming and boating. Eighty-eight out of 1000 people in Seattle own watercraft-one of the largest ratios in the country.

Following sections describe water resources, with special attention on water quality, hydrology, and use.

Fresh Surface Waters

Major surface waters in the study area are shown in Figure 2-6. Surface water is abundant due to the combination of heavy rainfall and local topography. The physical description of these surface waters is shown in Table 2-2.

The suitability of these surface waters for various beneficial uses is summarized in Table 2-3. Present water quality of the study area rivers is summarized in Table 2-4, and DOE criteria for State of Washington Water Quality Standards are shown in Appendix Table D-1. Locations of combined sewer overflows are shown in Figure 2-7.

Lake Washington. Lake Washington is located in the heart of Seattle, and is surrounded by urbanization to the west and suburban development to the east. Physical data is indicated in Table 2-2. Source and outlet are shown on the map, Figure 2-6. Water quality parameters are shown in Table 2-5.

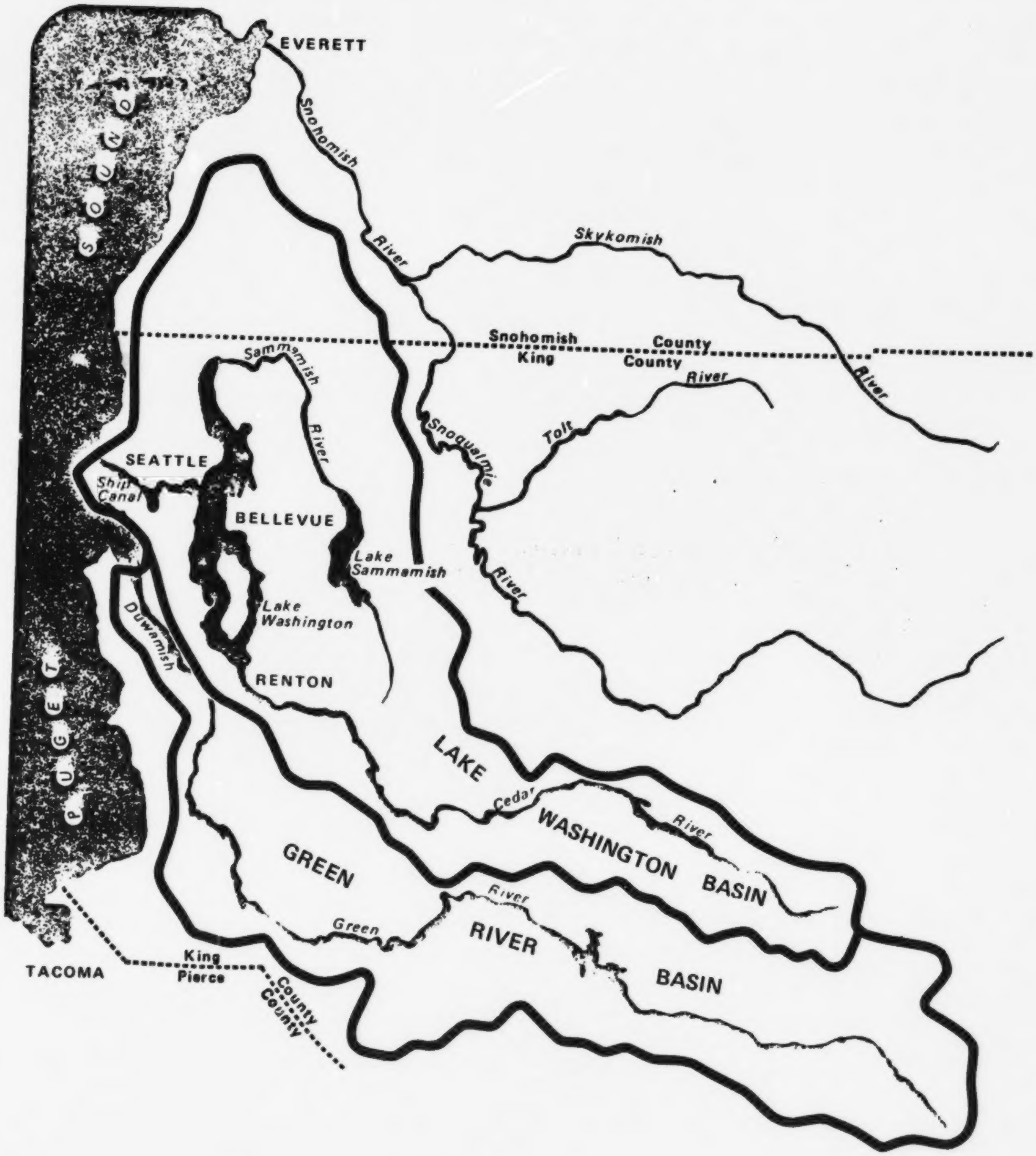

EVERETT
SOUND
Snohomish River
Skykomish River
Snohomish County
King County
Sammamish River
Tolt River
Snoqualmie River
SEATTLE
Ship Canal
BELLEVUE
Lake Sammamish
Lake Washington
Duwamish
PUGET
RENTON
LAKE WASHINGTON BASIN
Cedar River
GREEN RIVER BASIN
Green River
TACOMA
King
Pierce
County
County

FIGURE 2- 6
SURFACE WATERS

TABLE 2-2

PHYSICAL DESCRIPTION

Water Body	Area/Volume	Total Length (mi)	Width (mi)	Average Depth (feet)	Drainage (sq mi)	Outflow (cfs)			Source	Mouth/Outlet	DOE Classification	Principal Uses	
						Mean	High	Low				Water	Adjacent Land
Cedar River		50			188	700[a]		184[a] (Jul, Aug, Sep)	Cascades	Lake Washington	A/AA	Water supply (Seattle); power; fish migration & propagation; recreation	Forest, agriculture, residential, industry
Sammamish River		14			196	270	1300 (Dec-Jan)	72 (Jul/Aug)	Lake Sammamish	Lake Washington	AA	Recreation; fish migration	Recreation, agriculture, residential
Green River		80			483[b]	1345[c]		107[c] (Jul/Aug)	Cascades	Duwamish River	A/AA	Water supply (Tacoma); fish migration & propagation; recreation	Agriculture, recreation, forest
Duwamish River		11			483[b]	1560[d]		300[d] (Jul/Aug)	Green R., Black R.	Elliott Bay	B/A	Navigation; migratory fish	Industry
Lake Sammamish	7.6 sq mi/ 285,000 ac ft	8	1.5	58	98	0.162 km^3 per year			Issaquah Creek, Tibbetts Creek	Sammamish River	Lake	Recreation; migratory fish	Recreation, residential
Lake Washington	50 sq mi/ 2.88 km^3	22	1-4	101	476				Cedar R., Sammamish River	Ship Canal	Lake	Recreation; migratory fish; navigation	Residential, recreation, industry, commerce
Lake Union (and Ship Canal)		8							Lake Washington	Puget Sound	Lake	Migratory fish; recreation; commerce; industry; residential; navigation	Recreation, industry, commerce, residential
Green Lake	0.4 sq mi/ 3366 ac ft	0.8	0.5	12.5					City Water Runoff	None	Lake	Recreation	Recreation, residential, commerce
Puget Sound	1016 sq mi	80		930 max	11,000				Western Washington	Admiralty Inlet	AA	Shipping; recreation; industry; commercial fishing; waste discharge	Industry, commerce, residential, recreation

[a] At Landsburg
[b] Above Tukwila
[c] At Auburn
[d] At Tukwila

TABLE 2-3

Instream Use of Area Rivers

Green River Basin CHECKPOINTS	INSTREAM USE Fish Life	Drinking Water	Swimming	Viewing	Stock Watering	Industrial-Process Water	Recreational Boating	Irrigation	Industrial Cooling (Power)	Commercial Navigation	Wastewater Discharges
10. Green River above Palmer	▨ I	A									
11. Newaukum Creek above Mouth	▨ U			▨ U	A			A			▨ I
12. Big Soos Creek above Mouth	A		▨ A	I	I			I			▨ I
13. Green River above Auburn	I		▨ A	I	▨ I	▨ I	▨ I	▨ I	▨ I		
14. Green River above Tukwila	A		▨ U	A	▨ U	▨ A	▨ A	▨ A	▨ A		I
15. Black River Tributaries at Estuary	▨ U			▨ U							▨ I

Lake Washington Basin CHECKPOINTS	INSTREAM USE Fish Life	Drinking Water	Swimming	Viewing	Stock Watering	Industrial-Process Water	Recreational Boating	Irrigation	Industrial Cooling (Power)	Commercial Navigation	Wastewater Discharges
1. Cedar River above Landsburg		A		I							
2. Cedar River above Renton	U	▨ U	▨ A	A	▨ A	▨ A	▨ A	▨ A	▨ U		
3. Issaquah Creek above Mouth	A			A	A	▨ U		▨ A			▨ I
4. Lake Sammamish	A		I	A	▨ A	▨ A	I	▨ A			▨ I
5. Sammamish River above Kenmore	U		▨ U	U	▨ A	▨ U	U	A			▨ I
6. May Creek above Mouth	▨ A			A							▨ I
7. Thornton Creek above Mouth	▨ A			U							▨ I
8. Lake Washington	I		A	I		▨ I	I		▨ I	▨ I	I
9. Lake Union	A		▨ A	A		A	A		I	▨ I	I

USE: ☐ Major ▨ Minor QUALITY: I Ideal A Acceptable U Unacceptable

TABLE 2-4

Water Quality Parameters (1973) of Seattle Metropolitan Area Rivers

	Green (at Tukwila)	Duwamish	Cedar	Sammamish
Flow Rate (cfs)				
Mean Annual	1,345	1,560	700	270
Summer Low	107	300	184	74
Dissolved Oxygen (mg/l)				
Mean	N.D.	N.D.	11	7
Low	6	3	9.5	8.5
High	12.0	N.D.	12	13.
Trend, in past 10 yrs.	slightly better	Worse	None	None
#Violations /yr.	rare	every summer	None	every other summer
Temperature ($^{\circ}$C)				
Mean	N.D.	N.D.	N.D.	20
Low	4	N.D.	4	5
High	22	N.D.	19	40
#violations /hr.	some in summer	N.D.	some in summer	all summer
Coliform				
Mean	700	N.D.	500	1,500
Low	200	600	50	200
High	2,500	7,000	2,300	15,000
Trend	tenfld decrease	N.D.	None	None
# violations /yr	Occasionally	most of year	occasional	continual
Classification, based on DOE Standards	A to AA	B	A	AA

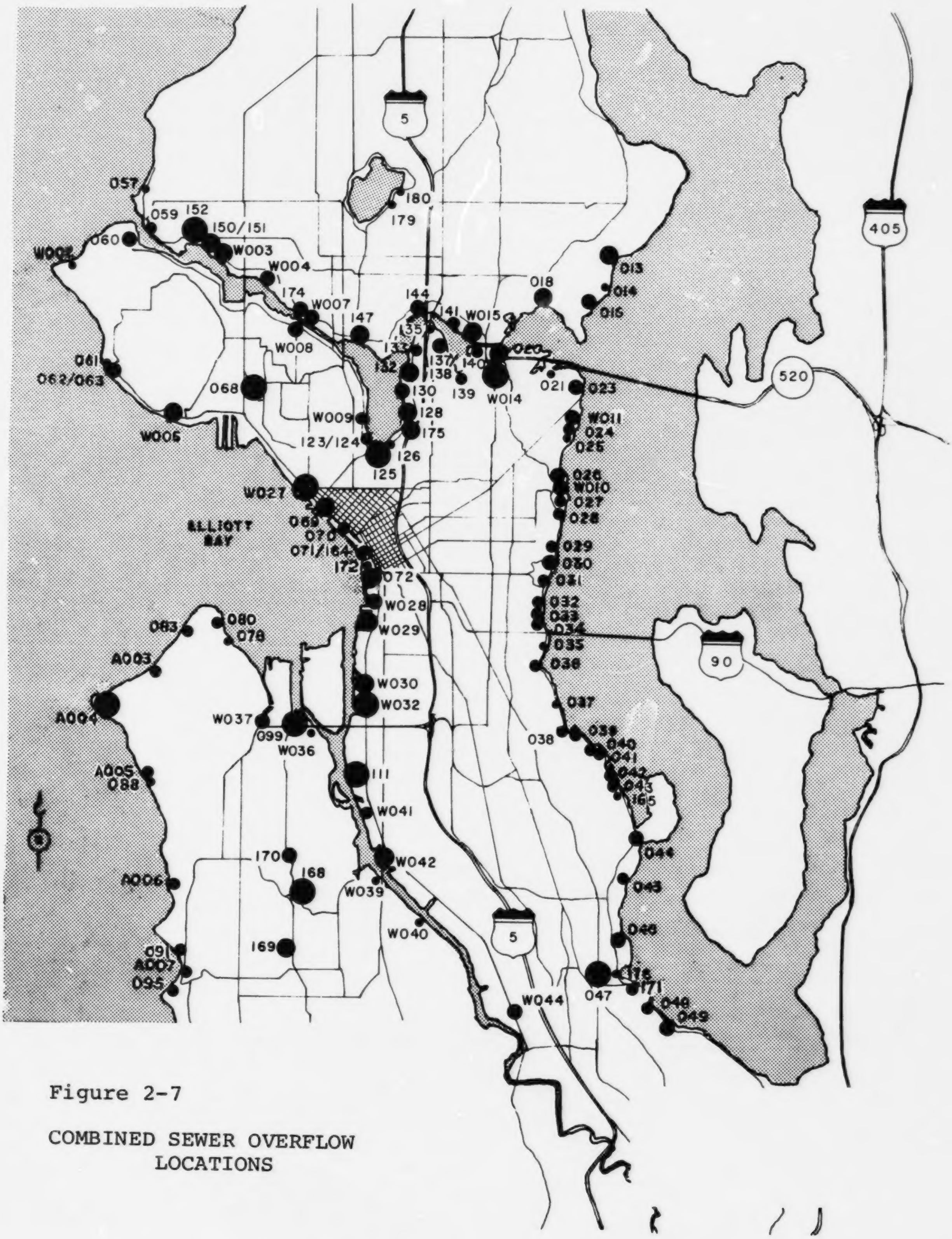

5
405
520
90
5
057
059
152
150/151
060
W002
W003
W004
174
W007
W008
061
062/063
068
W005
180
179
144
141
W015
147
135
133
132
137
138
140
139
W014
020
018
013
014
015
021
023
W011
024
025
130
128
175
W009
123/124
126
125
W027
ELLIOTT BAY
069
070
071/164
172
072
W028
W029
026
W010
027
028
029
030
031
032
033
034
035
036
083
080
078
A003
A004
W037
099
W036
W030
W032
037
038
039
040
041
042
043
165
A005
088
111
W041
170
168
W042
W039
A006
044
045
046
W040
169
091
A007
095
W044
047
176
171
048
049

Figure 2-7

COMBINED SEWER OVERFLOW LOCATIONS

Table 2-5

Suggested Criteria for Judging the Trophic Status of Temperate Lakes and the Respective Values for Lake Washington and Lake Sammamish

Item	Oligotropic	Eutrophic	Lake Washington	(1974) Lake Sammamish
Chlorophyll·a µg/l (growth season mean)	0-4	10-100	4.7	6.8
Primary productivity mgC·m^2 per day (growth season mean)	30-300	.000-3000	350	775
Hypolimnetic O_2 deficit in mgO_2/cm^2 per day (mean rate)	.025	.055	-	0.06-0.1
Ortho PO_4-P in µg/l (winter mean)	-	10	16.5	12
Total P annual supply in g/m^2 per year for mean depth 32.9m	.22	.42	.48	0.06
Total N annual supply in g/m^2 per year for mean depth 32.9m	3.00	6.00	4.33	3.84
Secchi: Depth (summer mean) m	-	-	N.D.	3.1

Sewer lines were diverted from Lake Washington in 1965, and since then the quality of this lake has improved remarkably. The dissolved oxygen content has increased, coliform levels have decreased, and the nuisance alga *Oscillatoria rubescens* has decreased greatly. When the diversion was being considered in 1965, it was predicted that 55% of the phosphorus and 12% of the nitrogen intakes would be diverted. In fact, concentrations of phosphate (PO_4 -P) have dropped 75% from the 1960's (Metro, 1976) and are now at 1950 levels. However, nitrogen concentrations have increased.

The outlet of Lake Washington was changed in 1916 from Black River, which entered the Duwamish River at Renton, to the man-made Ship Canal which passes through Lake Union to Puget Sound. To prevent Puget Sound's saltwater from intruding into Lake Washington, the water level of Lake Washington is maintained at 21 feet above sea level by locks.

Combined sewer overflows discharge a mean annual flow of 16.4 million gallons to Lake Washington. Data of overflows during two storms in August, 1976 were taken at the Madison outfall into Lake Washington (#023). The total coliform levels in the receiving waters at "first-flush" exceeded state standards of 240 counts/100 ml, (ranging from 250 to 3700), but usually subsided to levels below the health standard within 96 hours (Combined Sewer Overflow Studies, Metro, 1976). Fecal coliforms were generally 10 to 50% of the level of total coliforms. Since most fecal coliforms originate in human waste, this could indicate the primary coliform loading is from other sources, such as soil or street runoff. It is not known how representative this data is of other overflows into Lake Washington. More data should be acquired for a complete understanding of the impact of CSO's.

Because of Lake Washington's location in the center of Seattle, it plays a prominent role in the region. It is lined by at least eleven public beaches, is traveled by many pleasure craft, and provides much other recreation. These beaches sometimes experience coliform counts which exceed state standards.

Lake Sammamish. Lake Sammamish skirts the Seattle metropolitan area to the east of Lake Washington. Its shores have recently undergone residential development. Physical data is indicated in Table 2-2. Sources and outlet are shown on the map, Figure 2-6. Water quality parameters are shown in Table 2-4.

Algal blooms during spring and summer sometimes impair recreational use. These phytoplankton sink in the fall to create anaerobic conditions in the bottom waters. Secchi disk, a measure of water clarity, shows a light penetration of 3.0 meters (mean summer) (Metro, 1976).

Some sewer outlets were diverted away from Lake Sammamish in 1965; since then, blue-green algae have decreased in abundance, which may be an indication that the lake is showing some response to nutrient diversion. However, overall, the water quality has not changed significantly (Metro, 1976).

There are urban storm water discharges to Lake Sammamish, which possibly have an effect on the nearshore waters, but no combined sewer overflows. There are no significant industrial or municipal wastewater discharges to Lake Sammamish.

Green Lake. Green Lake, located in Seattle above Lake Union, is in the middle of a recreation park. Physical data are indicated in Table 2-2.

Green Lake has been identified as eutrophic. Total phosphorus concentrations have an annual mean of 30 µg/l. Nitrogen has an annual mean of 15 µg/l. These nutrients are not normally limiting to algae growth (Metro, 1976). The dissolved oxygen drops to zero in the hypolimnion below 22 meters until the fall overturn (DOE, 1977). Algal blooms sometimes produce a scum on the lake surface, which collects on the shores and decomposes. Coliform bacteria standards at public beaches are exceeded one-third of the time. It is believed that most of the bacteria come from duck feces.

Green Lake has had a history of eutrophication. Sediment samples show that the lake has been highly productive for 6,700 years. In the last 25 years the rate of sedimentation has increased by a factor of nine.

The lake has been diluted for the past 15 years with 7-10 mgd of municipal water to control algal blooms and enhance public health and safety. This dilution has improved many quality parameters by a factor of four. Still there are occasional cases of "swimmers itch" (avian schistosomiasis) and algal blooms. Chemical herbicides were used to control the algae in 1974.

Combined sewers occasionally overflowing into Green Lake during the rainy season [less than 0.5 million gallons annually (Metro, 1977)] have a slight detrimental effect on the water quality. There are no industrial or municipal discharges into this lake.

Lake Union and Ship Canal. The man-made Ship Canal breaches the land between Lake Washington and Puget Sound in the heart of urban Seattle.

The Ship Canal has been classified as mesotrophic-eutrophic. The dissolved oxygen concentration, however, is low, especially in the stratified lower depths of Lake Union during the summer. Coliform bacteria levels often exceed state standards, especially at time of combined sewer overflows. Heavy metal concentrations in the Ship Canal sediments have been increasing in the past 80 years. The Ship Canal was last dredged of sediments in 1954 (DOE, 1977).

Salinity is monitored to prevent intrusions into Lake Washington. The locks include fish ladders through which the State Department of Fisheries hopes that more than a million salmon annually will pass by 1980. These salmon proceed to Lake Washington and most continue up the Cedar and Sammamish Rivers.

The Ship Canal receives an input from combined sewer overflows of 186 million gallons per year, which could have a detrimental effect on water quality. Industries also discharge to Ship Canal and Lake Union.

The Ship Canal was constructed in 1916 to allow vessel travel between Lake Washington and Puget Sound. Today the Ship Canal is probably the most highly traveled body of water in the Pacific Northwest.

Cedar River. The Cedar River originates in the Cascade Mountains, then flows through the alluvial plain to discharge into Lake Washington at Renton. Above Renton, much of the Cedar River basin is sparsely developed. Hydrologic and water quality data are shown in Table 2-4. Cedar River will not be directly affected by any of the alternatives.

Green River. Hydrologic and water quality data are shown in Table 2-4.

The Renton sewage treatment plant discharges into the Green River at Renton (the point where it is renamed the Duwamish). This discharge apparently has a significant impact on river quality, increasing nitrate and phosphorous levels. Further, there are at least six major industrial discharges into the Green River.

Above Renton, the Green River would not be affected by any of the alternatives.

Sammamish River. Hydrologic water quality data are shown in Table 2-4. Since tributaries to the Sammamish River originate in the foothills, flows are not affected by snow melts at higher elevations.

The Sammamish River channel is narrow, shallow, and slow moving. It was widened, deepened, and straightened in 1964 by the U.S. Army Corps of Engineers.

There are a few industrial discharges, but none from municipal or industrial wastewater treatment plants. Non-point waste sources include urban runoff, failing on-site sewage disposal systems, horse and cattle pasturage, and park and golf course fertilization.

The Sammamish River water quality would only be directly affected by Alternative H, which incorporates wastewater discharges in the vicinity of Lake Sammamish.

Groundwater

Groundwater comprises 10% (15 mgd) of the area's water supply. Substantial users of groundwater are Renton (5.6 mgd), Kent (4.7 mgd), Redmond (0.6 mgd), Issaquah (0.5 mgd) and other small, primarily irrigation, districts (2.6 mgd). A well field is proposed for the Georgetown-Kangley area. Some localized well fields were recently closed when Seattle water became available.

Generally, it can be assumed that 16 inches of rainfall is available annually to recharge the water table. In urban areas, one half of the rain water is lost for groundwater recharge as it flows through storm drains or infiltrates into the sanitary sewers.

The metropolitan area soils are predominantly glacial and sedimentary, and therefore range from fairly impervious tills to highly permeable strata which have a storage volume of as much as 20 percent of total soil volume. Most of the shallower aquifers, which may be as shallow as 50 feet, are in hydraulic continuity with adjacent rivers.

Groundwater recharge is from direct precipitation from local streams, or higher elevation aquifers. There are four known aquifers in the foothills (the Georgetown-Kangley, among others) which eventually discharge into the rivers. There are also recharge zones in the Federal Way region and in the swales of the Alderwood drift plain.

Most water tables and wells along Puget Sound stand above sea level, so there is no apparent immediate danger of saltwater intrusion.

Water Supply

The water supply facilities for the Seattle metropolitan area are shown in Figure 2-8. Approximately 130 mgd is provided by the Cedar River Landsburg Diversion. Another 60 mgd is available from the Tolt River diversion. The remaining 15 mgd is supplied by groundwater. Distribution of the water supply is 92 mgd for residential, 17 mgd for commercial, 18 mgd for industrial and 36 mgd for public and miscellaneous users.

Metro's West Point, Carkeek Park, Richmond Beach and Renton wastewater treatment plant service areas receive water from the Tolt River system. This has very low levels of dissolved minerals and a low pH, which combine to make it corrosive.

Heavy metal ions are displaced from distribution system materials, as indicated by the comparison of running and standing water quality. Ultimately, these metals reach the wastewater treatment facilities where they are substantially removed or discharged to receiving waters, depending on the selected treatment process.

The Cedar River system supplies water to the Alki wastewater treatment plant service area, plus portions of the West Point and Richmond Beach service area. Water quality of the Cedar River supply, indicates it contains more dissolved minerals than the Tolt supply, has a high pH; and generally is expected to be less corrosive.

To meet future water demands, the Seattle metropolitan area is considering greater diversions of the Cedar River and new development of groundwater, both locally and at the proposed Georgetown-Kangley well field (Metro, 1974). Seattle is seeking legal rights to 300 mgd of Cedar River water, but the case has not been completed.

Flood Levels

Flood level data for the existing and proposed sewage treatment plants are given in Table 2-6. Of potential concern are the Carkeek and Diagonal Way treatment plants sites, situated only two feet above the one hundred year high water levels. Adjacent sludge basins, which are often lower than the rest of a facility, may have to be protected from flood waters.

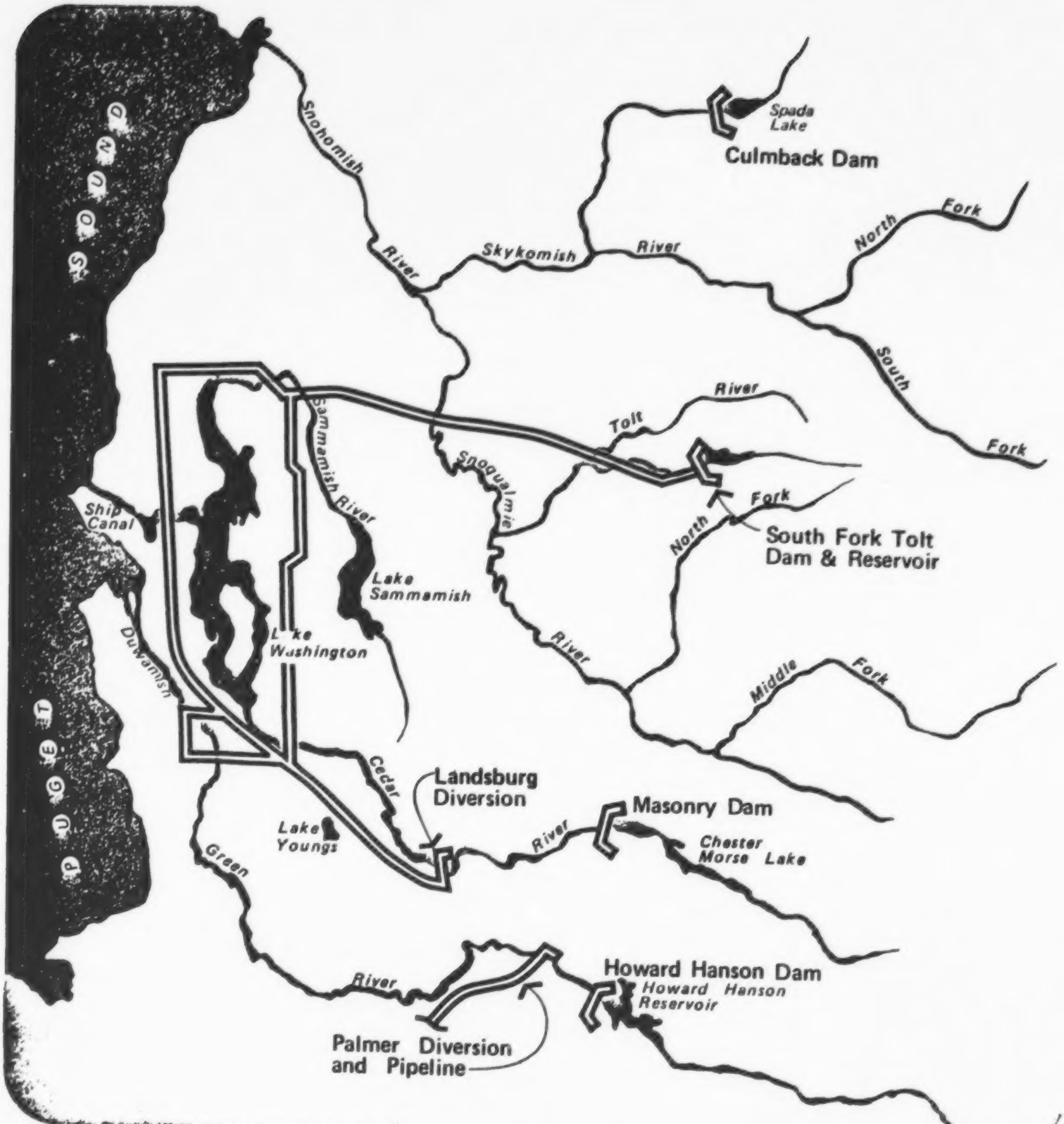

PUGET SOUND
Snohomish River
Spada Lake
Culmback Dam
Skykomish River
North Fork
South Fork
Tolt River
Snoqualmie River
Sammamish River
Ship Canal
South Fork Tolt Dam & Reservoir
North Fork
Lake Sammamish
Lake Washington
Duwamish
Middle Fork
Cedar River
Landsburg Diversion
Masonry Dam
Lake Youngs
Chester Morse Lake
Green River
Howard Hanson Dam
Howard Hanson Reservoir
Palmer Diversion and Pipeline

FIGURE 2-8
CURRENT WATER SUPPLY FACILITIES

TABLE 2-6

ONE HUNDRED-YEAR FLOOD LEVELS AND/OR TIDE LEVELS AT PROJECT SITES

Site	Average Elevation	100 Year Water Level	Ground Surface	Depth to 100 Yr Flood Level
Carkeek Park	40 ft	38 ft	40 ft	2 ft
West Point	S.L.	8.4	19	10.6
Richmond Beach	19	8.4	6-30	10.6
Alki	30	10	30-33	20±
Commodore Way	45	25	25-55	20
Interbay	55	10±[c]	43-65	45±
Diagonal Way	12±	10±[c]	12±	2±
Duwamish	21	8.4[a]	21	12.6
Kenmore near Lake Washington	25	16[d]	25	9
North and South Lake Sammamish		32.5[b]	low land	on surface

[a] Based on high tide level

[b] Lake Sammamish 100-year flood at 32.5 ft.

[c] Near Puget Sound add 1.7 ft to highest tide level

[d] Lake Washington: controlled water level

SOURCE: Metropolitan Engineers

Puget Sound

Since Puget Sound is the effluent disposal site for much of the study area now and will continue as such in the future, an understanding of its physical, chemical and biological characteristics is central to the impact analysis.

In an effort to document any effect, beneficial or adverse, of primary effluent from its four Puget Sound outfalls, Metro has sponsored a series of eleven studies collectively called the Puget Sound Interim Studies (PSIS). As of June 1977, ten final reports were completed. These studies focused primarily on parameters treatable or controllable by Metro, but also seek to generate general information on the central basin of Puget Sound. The studies include (1) tracking of effluent from West Point by dye tracing (W. P. Bendiner and T. E. Ewart, U. W.), (2) current tracking by drogue tracers (Ebbesmeyer, Evans-Hamilton, Inc.), (3) evaluation of intertidal flora and fauna of beaches adjoining Metro's marine discharges (K. Chew et al., U. W.), (4) measurement of heavy metals in water column, sediments and biota of Puget Sound (W. Schell, U. W.), (5) nutrient observations in Puget Sound (E. E. Collias, U. W.), (6) phytoplankton productivity studies and possible effects of Metro discharges (Evans-Hamilton, Inc.), (7) analysis of subtidal sediments and benthic organisms (Harmon, Serwold and Sylvester, Shoreline Community College), (8) demersal and pelagic fish (B. Miller, U. W.), (9) acoustical tracking of pelagic fish and zooplankton near outfalls (T. S. English), (10) bioassay of marine organisms, response to toxic materials in effluent (Q. J. Stober, U. W.), (11) current properties and mixing of effluent, water quality studies (Environmental Quality Analysts, Inc.).

The PSIS have provided the major portion of information subsequently discussed in this document on Puget Sound. Physical conditions are described in the following sections on oceanography and water quality. Biologic conditions are presented later in this chapter. For more detailed descriptions of the studies the reader is referred to the studies themselves or to the Studies' Summary (Duxbury, 1976).

Oceanography. Puget Sound is a fjord-like estuary carved by glaciers from an older river valley system. An estuary is a semi-enclosed area of seawater diluted by freshwater from rivers. The basic circulation pattern and net exchange of water between the Sound and the Pacific Ocean through the Straits of Juan de Fuca are influenced by the differences in temperature and salinity between freshwater and saltwater. As indicated in Figure 2-9, there is a net

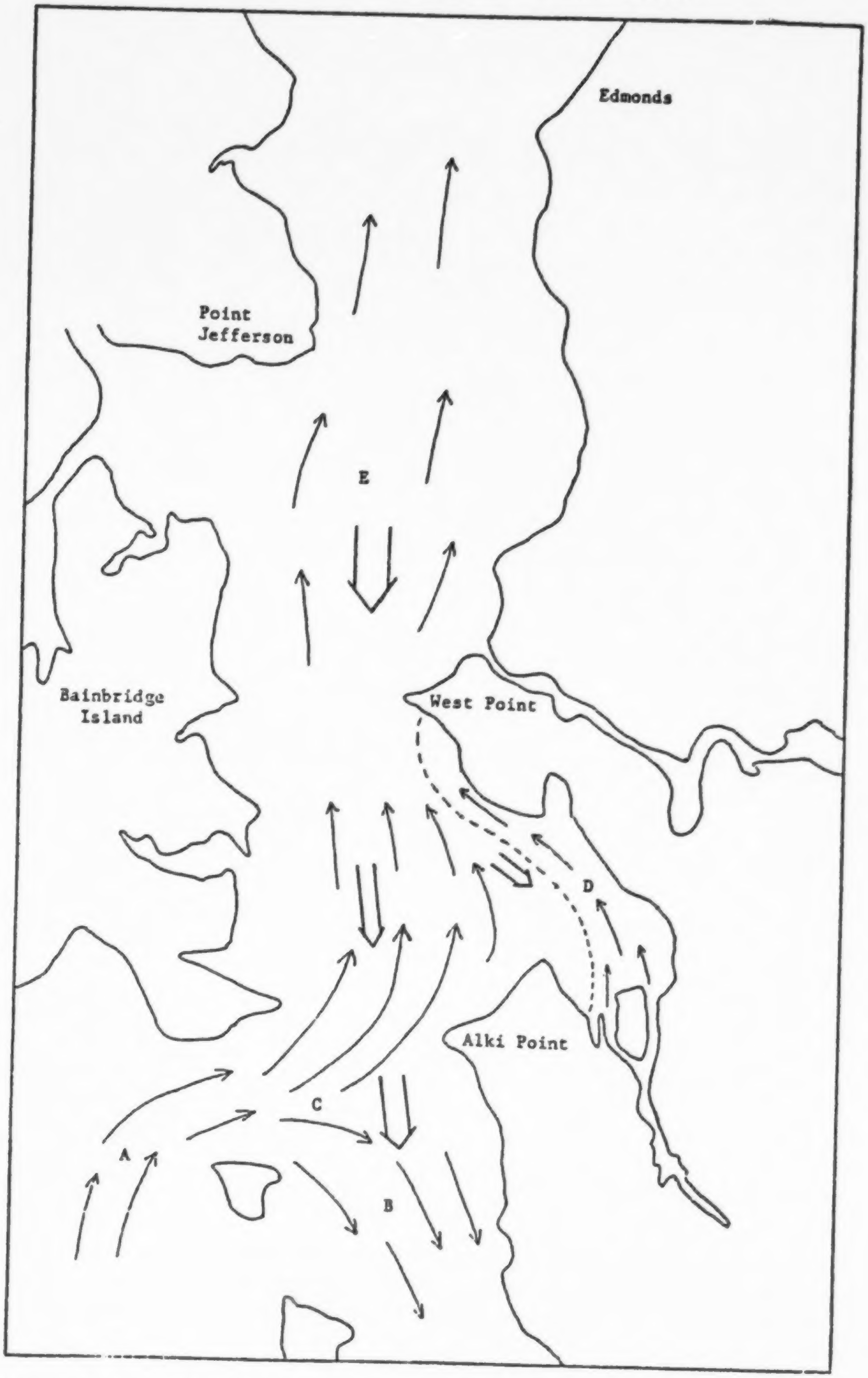

Edmonds
Point Jefferson
E
Bainbridge Island
West Point
D
Alki Point
C
A
B

Figure 2-9. Circulation in central Puget Sound. Letters and solid arrows denote surface circulation above approximately 50 m. as follows: A - outflow from Colvos Passage; B - southward flow due to 'pumping' action of Tacoma Narrows; C - surface divergence of output from Colvos Passage; D - outflow from Duwamish River; E - net northward flow. Large arrows denote deep circulation beneath approximately 50 m.

outflow of less dense freshwater in the upper 150 feet of the Sound and a net inflow of more dense saltwater at greater depths.

The Sound is a series of interconnected basins separated by shallows called sills which restrict deep water circulation. Flushing of a basin occurs when dense seawater in a seaward basin cascades over the separating sills. Between flushings, deep water in a basin becomes higher in nutrients and lower in dissolved oxygen. Flushing rates of basins vary. The replacement time for the entire Sound is 218 days, while certain basins flush in less than two weeks depending on runoff, tides and wind conditions. Flushing rates for surface waters, which are under investigation, may be less.

More complete intermediate and shallow circulation is driven by freshwaters from rivers flowing in at depth. However, since freshwater inflow is less dense than saltwater, some layering of water in the Sound results. A shear zone of little or no net motion occurs at the interface between these water masses at depths of 120 to 180 feet. In this zone, waters tend to roll back and forth and may remain in place over many tidal cycles.

Superimposed on the net flows of the Sound are oscillatory tidal flows. About 5% of the total volume of the Sound is exchanged on each tide, but much of the water taken out on an ebb tide returns on the following flood tide. Tides in Puget Sound are of the mixed type, characterized by two highs and two lows of unequal heights each tidal day (24.84 hours). The greatest inequalities are between the heights of successive low waters. The mean tidal range at Seattle is 10.7 feet.

Research on the surface tidal currents of Puget Sound has been conducted on a hydraulic tidal model of Puget Sound at the Department of Oceanography, University of Washington. Figures 2-10, 2-11, 2-12, and 2-13 portray the model results in the central basin for the maximum ebb, slack water, maximum flood, and the following slack period. While winds and gravity cannot be modeled, the study results are generally descriptive of actual conditions.

During maximum flow periods, cross-channel variation in tidal flow is minimal, with eddies being confined next to the shore on the lee side of points that jut into the basin. During slack water periods, the driving force on the main channel flow dissipates and reverses its direction. Eddies formed behind headlands then expand, migrate away from shore and interact with each other. Mixing is therefore maximized during this slack water period by eddies as opposed to the predominately horizontal transport that occurs at maximum

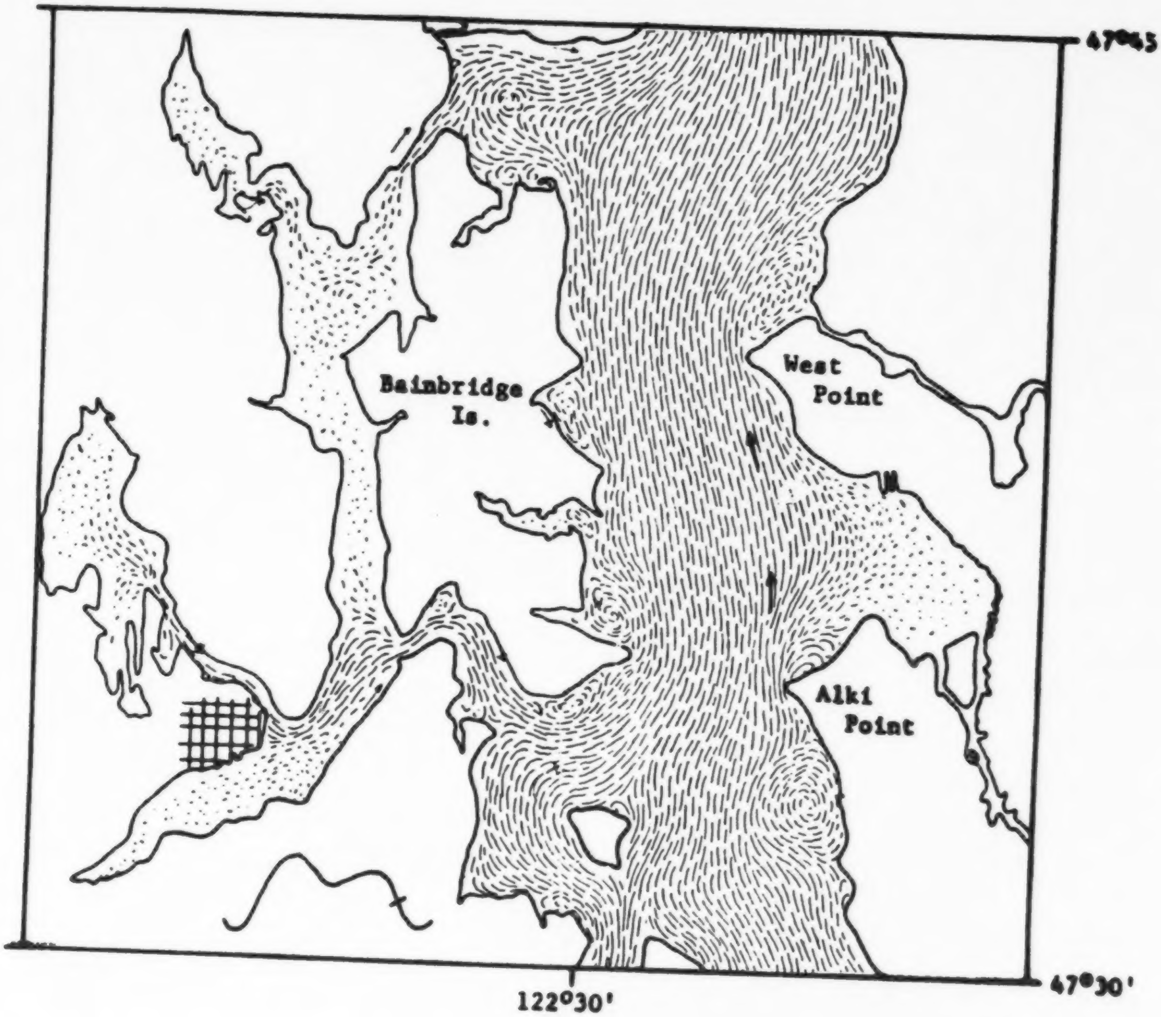

47°43'
Bainbridge
Is.
West
Point
Alki
Point
122°30'
47°30'

Figure 2-10 Surface tidal circulation of Puget Sound during major ebb tide (From Duxbury, 1976)

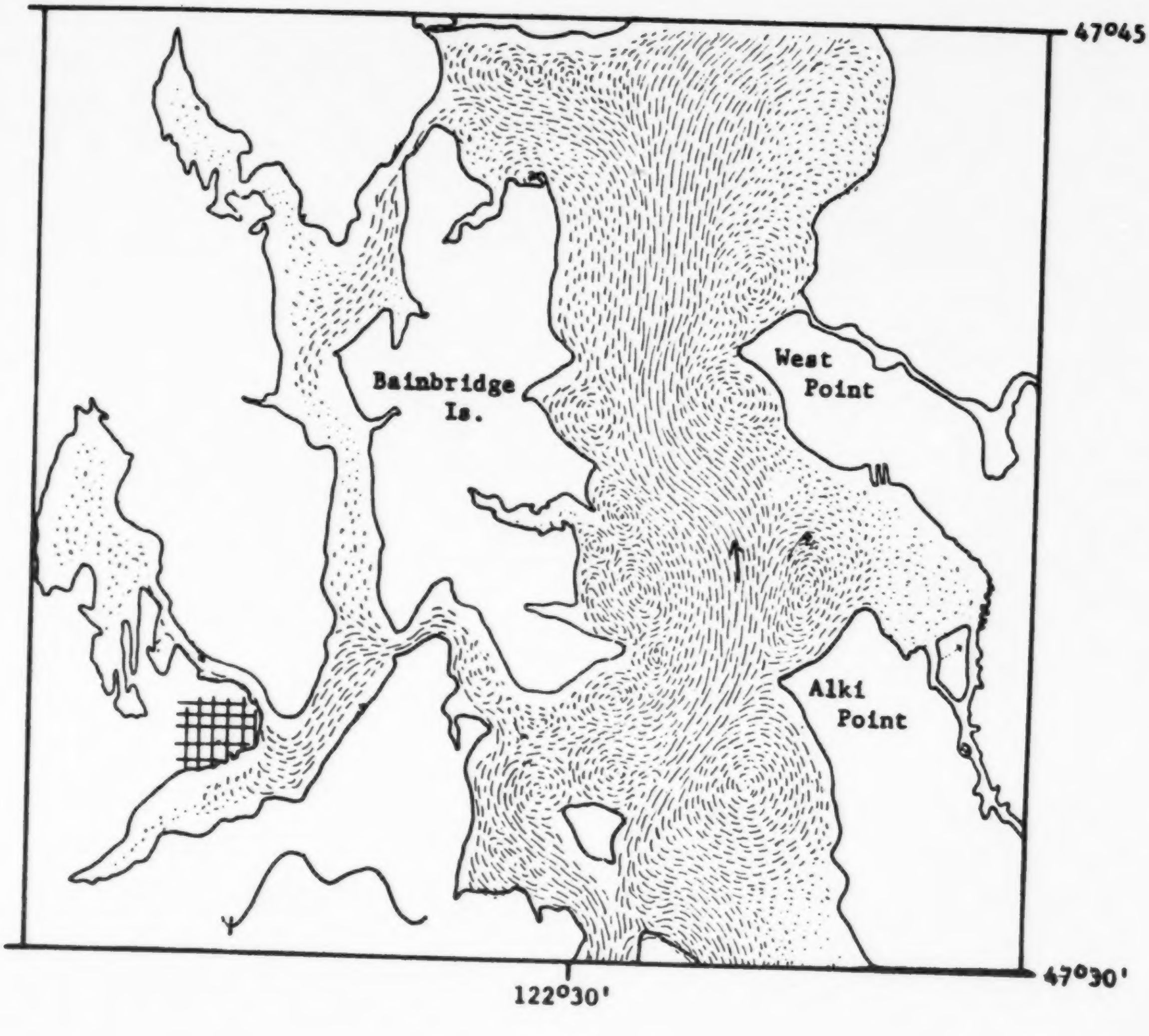

47°45'
Bainbridge Is.
West Point
Alki Point
122°30'
47°30'

Figure 2-11 Surface tidal circulation of Puget Sound at lower low water. (From Duxbury, 1976)

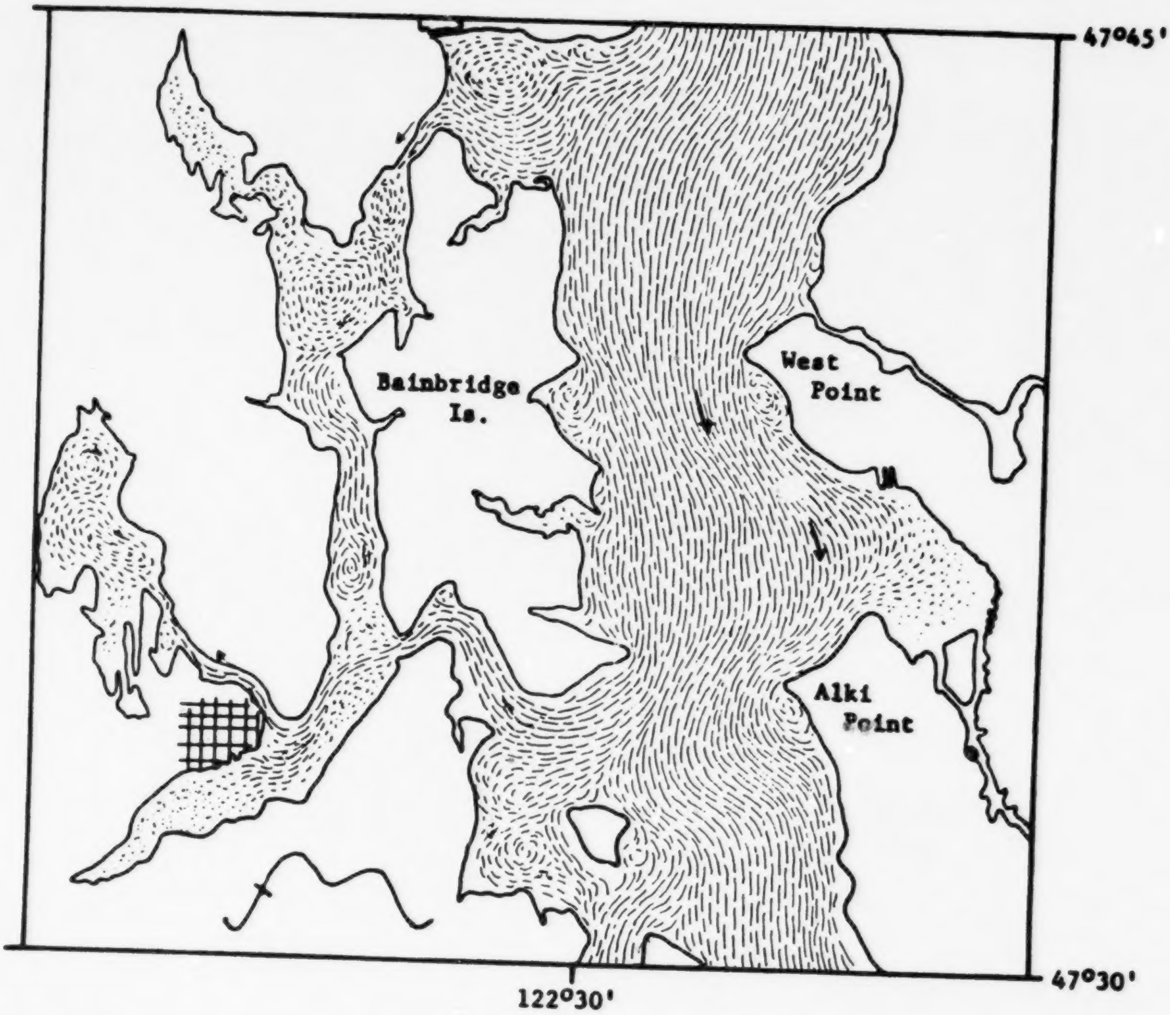

47°45'
Bainbridge Is.
West Point
Alki Point
47°30'
122°30'

Figure 2-12 Surface tidal circulation of Puget Sound at major flood tide. (From Duxbury, 1976)

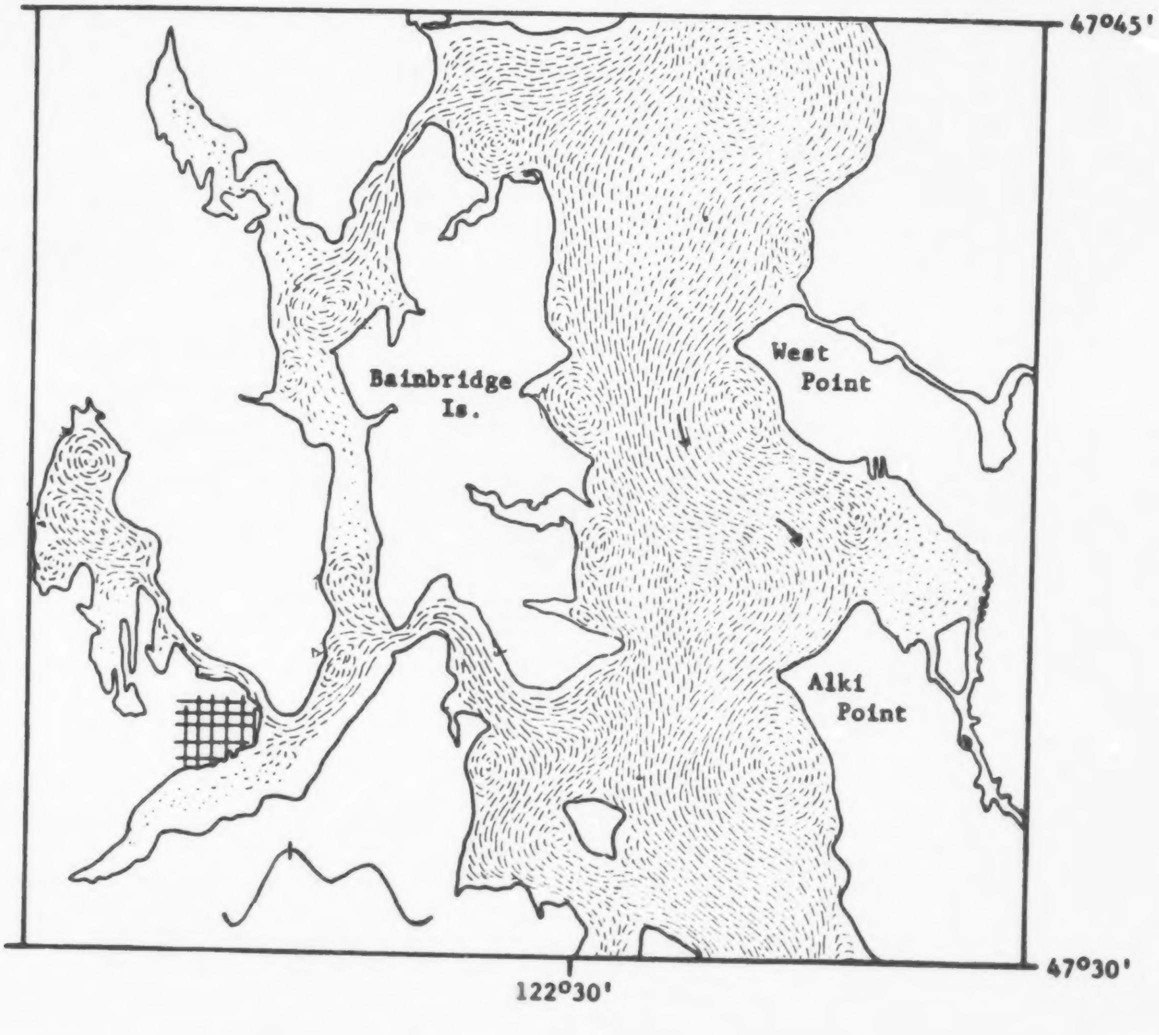

47°45'
West Point
Bainbridge Is.
Alki Point
47°30'
122°30'

Figure 2-13 Surface tidal circulation of Puget Sound at higher high water. (From Duxbury, 1976)

ebb and flood. As a result, effluent discharged along the east side of the central basin is diluted and dispersed more by eddies at slack water than by strong horizontal movements at flood and ebb tides.

Puget Sound is generally little affected by wind as it is partly protected by mountains on three sides. Mixing near river mouths and water column stability are strongly affected by local winds but water levels and circulation patterns are affected only by major storms. In most areas, the largest wind waves observed rarely exceed 4.3 feet (Duxbury, 1975).

The mixing of the Sound affects temperatures, salinity, nutrient levels and dissolved oxygen in surface waters of the Sound. Seasonal changes in the seawater coming in from the Pacific Ocean through the Straits of Juan de Fuca are caused by coastal upwelling in summer and coastal downwelling in winter. Upwelled oceanic water is characterized by low temperatures and oxygen, high salinity and nutrients. Changes over several years, or even in a single year in the flow of oceanic water, in the strength of upwelling or in rainfall, are reflected in the water quality of Puget Sound. The waters of the Sound are turbid much of the year, primarily because of phytoplankton growth and sediment discharged by rivers. Both form turbid patches readily seen from the air. Surface waters are clearest in autumn when discharge is lowest.

Physical characteristics of Puget Sound also affect dispersal of effluent disposed therein. Tracing dye injected into West Point effluent indicated an initial dilution of about 140:1 at the diffuser. The effluent was usually observed rising rapidly from the discharge depth of 230 feet, 3,000 feet off West Point, to a zone varying from 120 to 180 feet which corresponds to the depth of the shear zone described previously. Two water samples collected at the beaches north and south of West Point during the dye studies (August 1974) contained dye at a dilution of 1:250 or about half the concentration found at the diffuser.

Tidal currents, turbulence and velocity cause the effluent to spread out and break up into filaments and patches. The plume moves northerly on an ebb tide, southerly on a flood tide. As the zone of little or no net motion is also at the 120 to 180 feet zone, the effluent is probably not flushed out of the Sound as fast as initial water mass movements would suggest, but is recycled back and forth over the outfall. Where this intermediate layer contacts the bottom, waterborne materials may be concentrated and deposited, as reflected in the distribution of subtidal sediments and biota (Harmon, Serwold and Sylvester, 1976). When the vertical stability of the water column breaks down, generally in summer, the effluent tends to surface, an event more common than previously predicted (Bendiner, 1976), but whose probability was not studied. This phenomenon has not been entirely explained. The surfacing of effluent is thought to be a summer phenomenon, perhaps associated with isolated freshwater patches from the Duwamish River and the Ship Canal, and the reduced stability of the water column in the absence of the general freshwater lid. The dye studies have also shown that effluent patches may become trapped in the eddies which form at ebb and flow tides on the north and south sides of West Point. No further studies have been performed to determine the frequency and distribution of effluent on east-side beaches. In the absence of water quality and shellfish data it is impossible to determine the probability and magnitude of these events and any associated public health risk. The dye study and benthic study confirm that studies of effects and fates of pollutants in Puget Sound cannot be limited to nearshore waters (upper 100 feet) as the distribution of effluent is due to deeper water movement patterns and the preferred plume position corresponds with changes in the benthic ecology at depths of 150 feet and more.

The fate and effects of effluent from the Carkeek Park sewage treatment plant were also evident from the benthic sampling studies of the PSIS. The Carkeek outfall appeared to correlate with the local distribution of (1) sediment having a hydrogen sulfide odor, (2) seeds, (3) arenaceous foraminifera (_Trochamina_), (4) _Buliminella elegantissima_, a foraminiferan shown to be associated with California outfalls, and (5) clams, snails and worms.

Water quality. The water quality in Puget Sound is influenced by the previously described mixing of fresh and saltwater, physical characteristics and circulation patterns, and the contribution of pollutants from various sources within the study area. Detail is available in the PSIS as well as other publications (Collias and Barnes, 1964; Duxbury, 1972-1975).

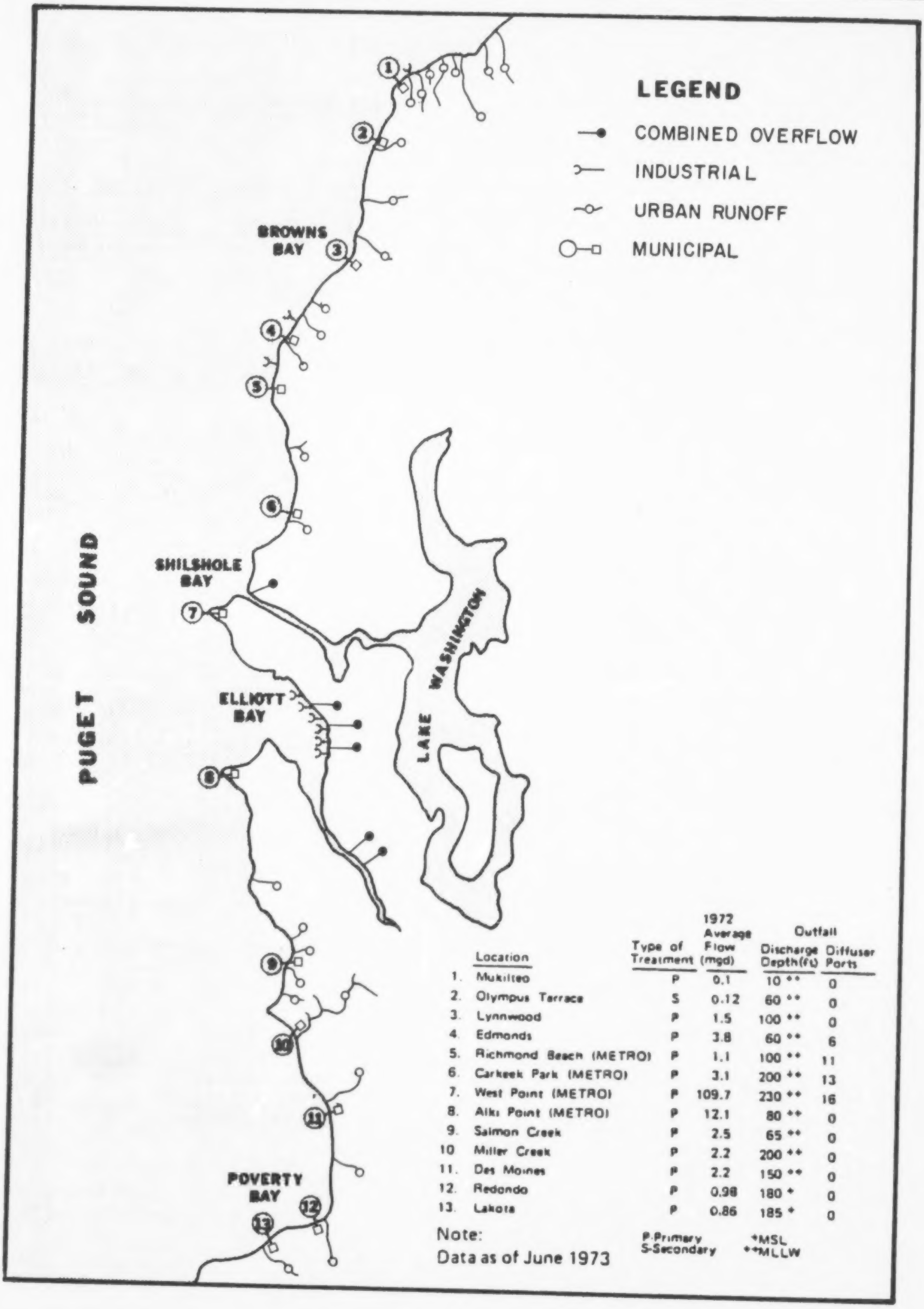
The waters of the Sound are a continuously changing mixture averaging about ten parts coastal or saltwater to one part river or freshwater with an average salinity of 28 0/00 (28 parts salt to 1000 parts water). During the summer, there is also a distinct thermocline or rapid temperature decrease with depth at 30 to 40 feet.

The major sources of pollutants in the study area are the municipal and industrial effluents and combined sewer overflows discharged to the east side of the central Puget

Sound basin as shown in Figure 2-14. Discharges from 16 sewage treatment plants contribute more than 185 mgd of treated wastewater to the basin. Of these, 15 are discharging to Puget Sound and two to the Duwamish River. With the exception of three secondary treatment plants, all provide primary treatment. The Washington Marine Atlas indicates that there are from 28 to 35 municipal dischargers to the central basin alone, excluding those to rivers like the Duwamish. By the year 2000, effluent discharges in excess of 500 mgd (RIBCO Part III, 1974) are expected. Pollutant loads to Puget Sound are thus expected to also increase significantly by 2005. Non-point and miscellaneous waste sources include air fallout from industry and automobile exhaust, dredge spoil, oil wastes or spills, garbage and sewage from ships and floating debris. Information on quantities of present and projected (year 2005) pollutant loads to the Sound from these sources is sparse, but present (1975) pollutant loads discharged to saltwater by Metro sewerage system and combined sewer overflows are estimated at 14,000 tons of solids per year. Projected loads (year 2005) are dependent on the selected alternative, as discussed in Chapter III.

Water quality and nutrient investigations were conducted as part of the PSIS with a view to identifying the effect of Metro's West Point treatment plant effluent on certain water quality parameters: temperature, salinity, density, dissolved oxygen, light transmittance reduction (turbidity) and pH. All parameters but pH were found relatable to the effluent plume. However, turbidity was the only parameter more than barely detectable. Turbidity decreased with distance from the source as expected. The study suggested that other water quality parameters be measured in order to characterize the effects of effluent on Puget Sound or that more sensitive tracers be employed.

The nutrient study data indicated that at slack water the effluent builds up temporarily near West Point's diffuser with concomitant increases in local concentrations of nitrate, ammonia, and phosphate and changes in temperature, dissolved oxygen, salinity and density. Chemical data collected along the central axis of Puget Sound did not reflect the effluent's influence. Since the Sound is a complex system with tremendous natural variability in its physical and chemical characteristics, this variation masks any effects that may be due to West Point's flow, though this flow is substantial. Whether future flows will also be barely detectable is difficult to predict. Future loadings of nutrients, however, were modeled by STR (1975) and suggest a 33% increase in


LEGEND
COMBINED OVERFLOW
INDUSTRIAL
URBAN RUNOFF
MUNICIPAL
BROWNS BAY
SHILSHOLE BAY
ELLIOTT BAY
POVERTY BAY
PUGET SOUND
LAKE WASHINGTON
1
2
3
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	Location	Type of Treatment	1972 Average Flow (mgd)	Outfall Discharge Depth(ft)	Outfall Diffuser Ports
1.	Mukilteo	P	0.1	10 ++	0
2.	Olympus Terrace	S	0.12	60 ++	0
3.	Lynnwood	P	1.5	100 ++	0
4.	Edmonds	P	3.8	60 ++	6
5.	Richmond Beach (METRO)	P	1.1	100 ++	11
6.	Carkeek Park (METRO)	P	3.1	200 ++	13
7.	West Point (METRO)	P	109.7	230 ++	16
8.	Alki Point (METRO)	P	12.1	80 ++	0
9.	Salmon Creek	P	2.5	65 ++	0
10	Miller Creek	P	2.2	200 ++	0
11.	Des Moines	P	2.2	150 ++	0
12.	Redondo	P	0.98	180 +	0
13.	Lakota	P	0.86	185 +	0

Note:
Data as of June 1973

P-Primary
S-Secondary

+MSL
++MLLW

FIGURE 2-14

MUNICIPAL AND INDUSTRIAL
EFFLUENTS DISCHARGED TO PUGET SOUND MAIN BASIN EAST SIDE

nitrogen in Puget Sound surface waters by the year 2000 as the result of estimated municipal and industrial loadings. The validity of the model is questioned, however, and other nutrient studies suggest that the effect of Metro discharges is probably minor and localized with respect to nutrients.

Studies of Southern California outfalls have shown biological changes associated with sewage effluent in areas in which little or no water quality changes could be measured, however (SCCWRP, 1975; Smith, 1976). Biological systems are perhaps more sensitive indicators of environmental change than are physical and chemical systems.

As the terminus of a drainage system, Puget Sound is a collection point for discharged materials, including heavy metals. Discharges from metropolitan centers are a major source of these materials. In the study area, West Point sewage treatment plant is a primary contributor; Richmond Beach, Carkeek Park and Alki are minor contributors. Other sources of metals in Puget Sound are industrial discharges, river and surface runoff, storm sewers carrying leachates and eroded material from land, airborne materials such as aerosols generated from fuel consumption, the protective paints and antifouling measures of vessels, and incoming saltwaters. Metals are removed from the Sound primarily by flushing and/or by sedimentation of particles with which they are associated.

Variations in input of metals to West Point correlated well with rainfall, especially for winter and spring months (Figure 2-15) in 1973, for which there is data. It is recognized that 1973 had little rain and the correlation may not be generally true. While rainfall may increase the total mass of trace metals delivered to the treatment plant and thus to the Sound, the increased flow also dilutes the effluent causing concentrations of metals in it to be lower. Summer and fall changes may be partially a function of water supply sources (Schell et al., 1976). Too, as described in the water supply section of this report, Seattle's soft, corrosive water tends to leach metals from pipes in the supply system, especially zinc, cadmium, copper and perhaps lead. West Point also receives industrial wastes which may contain high concentrations of metals. Determining the sources which contribute metals to West Point or any treatment facility is necessary for the evaluation of source control potential should metals in effluent be deemed a water quality problem. The inputs of copper, lead and zinc to Puget Sound have been estimated from several sources (Schell et al., 1977). Routine monitoring data collected by different agencies in the Puget Sound area are not presently adequate for an accurate evaluation of different

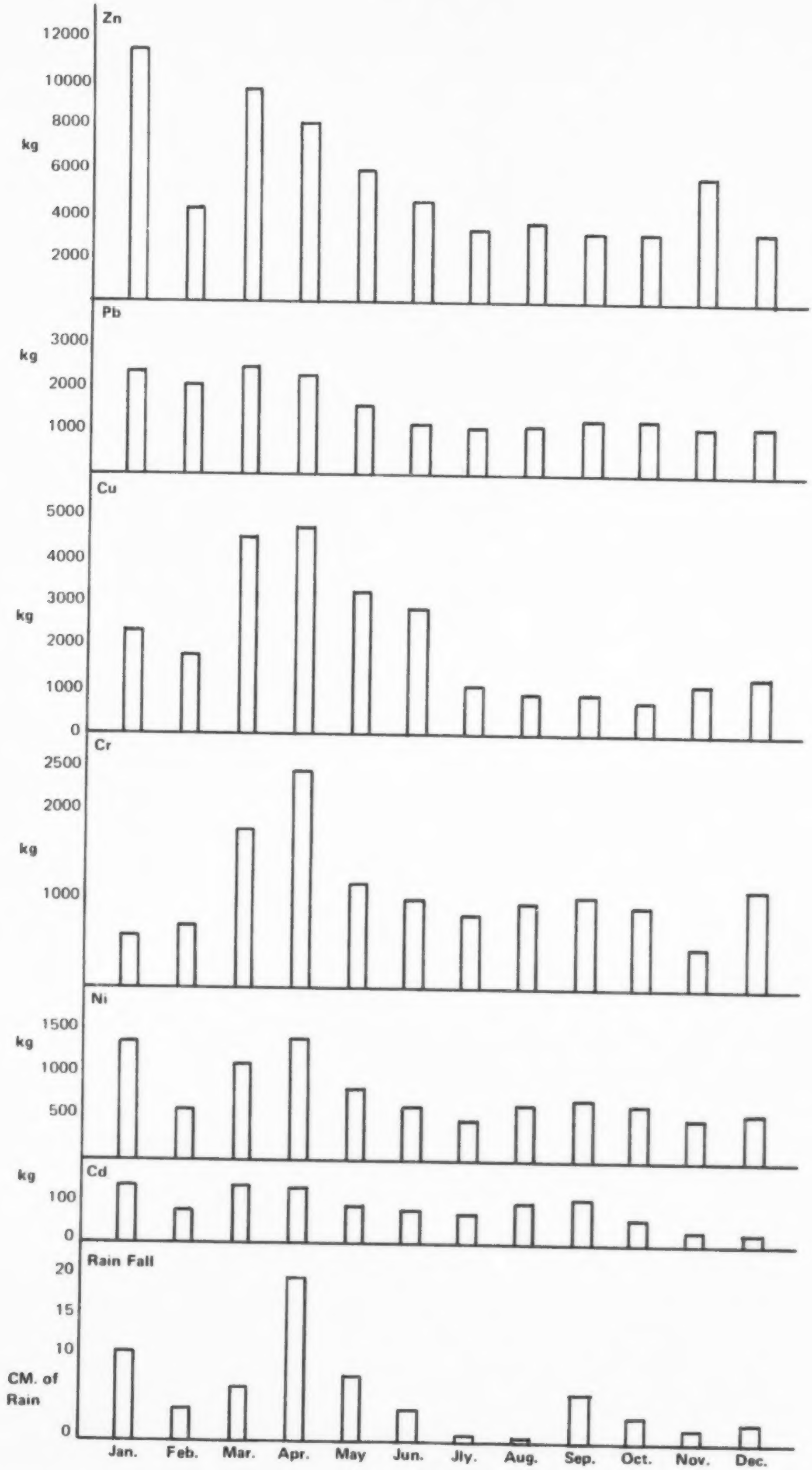


FIGURE 2-15 Monthly input of trace metals to Puget Sound at West Point in 1973.

trace metal sources.

Table 2-7 shows that Metro's West Point plant and the other minicipal plants are sources of minor or equal importance with other man caused sources. The table suggests the plants contribute small proportion of the estimated load, exclusive of industrial sources, of copper, lead and zinc, respectively. Although municipal contributions appear to be a small portion of the total input, their significance should be evaluated in terms of the conditions observed near the sites of metals deposition. The significance of Metro's inputs depends on sedimentation rates, biological uptake, residence times of waters and circulation near the outfalls and in the central Puget Sound basin (Schell et al., 1977).

Concentrations of heavy metals in central Puget Sound water, sediments and biota have been examined since many heavy metals, such as cadmium or mercury have toxic properties (Schell et al., 1976). Samples were taken at the four Metro outfall sites, in Shilshole and Elliott Bays, at Duwamish Head, off Four Mile Rock and at selected sites some distance further north and south. The Blake Island sampling site, assumed to represent background levels of trace metals in the central basin, had higher levels of metals than most sites sampled, including West Point, probably due to particular air and water circulation patterns. The metals found here, then, do not necessarily represent background levels in Puget Sound. No clear distribution pattern for metals emerged from the water column studies, but at all stations, levels of cadmium and lead were approximately an order of magnitude higher than in the open sea (Schell et al., 1976). Levels of zinc, copper, and nickel were the same or lower than open sea levels for these metals. These comparisons are tentative however as the concentrating method used is least efficient for lead and cadmium (Duxbury, 1976; W. Schell, personal communication, 1976). Identifying pollutant sources and distribution patterns in Puget Sound is currently problematic because of their number and variety and the complex circulation of the Sound.

Puget Sound sediments, an important sink for trace metals, were dated and metals analyzed from core samples as part of the PSIS heavy metals study (Schell et al., 1977). Mercury concentration tended to decrease with depth in the cores, showing enrichments in surface sediments of six to nine times the average background level in the Sound. At Blake Island, the surface enrichment factor was 17-18. The presence of dredge spoils at several sites was indicated from lowered organic carbon and nitrogen levels. The high enrichment factors suggest that potential problems may

Table 2-7

Total Copper, Lead and Zinc Inputs to Puget Sound[c] (Tons/Year)

Source[a]	Copper	Lead	Zinc	Estimated Standard Deviation
Rivers	714	1843	1473	50%
Duwamish	11	50	28	50%
Ship Canal	0.9	7	0.9	50%
Metro's West Point Plant	26	8	51	10%
Other Municipalities in the Puget Sound Area	20	14	24	50%
Atmospheric Input	41	248	74	50%
Urban Runoff (CSO)[b]	14	317	45	No Data
Vessel Protective Measures and Fuel Consumption	329-535	8-11	127-218	No Data
Advective Transport (Incoming Seawater)	278	278	793	50%

Note:

[a] Direct industrial discharges and dumping not included due to their complexity and lack of adequate data.

[b] Assumes all urban runoff overflows to Puget Sound. As this is not actually the case, values shown probably represent maximum inputs.

[c] The numbers, including the standard deviations, presented in this table are rough approximations, highly controversial and do not account for ionic forms of metals.

Source: Compilation of data from various sources in Schell *et al.*, 1977.

exist with mercury. The probable source or sources of mercury have not been specified. The PSIS metals study is inconclusive regarding the impact of Metro sewage discharge sites on observed distribution and concentration levels of heavy metals in Puget Sound.

At a given site, occasional variations appear in sedimentation rate, such as would result from slumping or spoil dumping. Near the West Point outfall, at a depth of 827 feet, a core indicated a rapid accumulation of sediments over the entire 48 cm core length. It has been suggested that this may reflect the deposition of sludge or natural sedimentation in the "deep hole" near West Point (Metropolitan Engineers, 1976). At the same time, it appears that no sludge builds up at the West Point outfall at a depth of 230 feet (Domenowske and Matsuda, 1969).

The picture is complicated by the dumping of Duwamish dredge spoils containing high levels of a number of industrial pollutants in Elliott Bay off Four Mile Rock. A study of dredge spoil contaminants indicates that fine particles, which are highest in trace metals, travel furthest. On an ebb tide, fine materials from the dump site reach West Point in five to six hours, and the beach south of West Point (where dye was found in an earlier study) in half that time. The concentrations of metals in the diluted effluent at the diffuser and in the dispersed spoils after one ebb tide are about the same (Schell et al., 1976). Zooplankton, however, ingest the fine particles and tend to selectively concentrate metal from them. In summary, information on heavy metals in Puget Sound water and sediments has been only recently developed. Preliminary analysis indicates the existing Metro discharges are not major contributors of heavy metals, but more information is needed to fully assess the impacts of these metals.

The Duwamish Estuary

The Duwamish Estuary includes the lower 13 miles of the Green-Duwamish River which drains the Green River basin through the major industrial area of Seattle for about eight miles. The lower six miles of the estuary have been dredged routinely for navigational access.

The entire Duwamish River is tidally influenced. Under high river flow conditions, however, water in the upper five miles of the estuary is always fresh regardless of tide. Under low flow conditions, saltwaters travel as far as ten miles above the mouth of the estuary. The average annual flow at Auburn is 1,360 cfs (cubic feet per second). The maximum recorded mean is 2,071 cfs (1972) and the minimum

107 cfs (1941).

Uses of the Duwamish fall into two potentially conflicting classes: (1) commercial shipping and waste disposal and (2) fisheries. Due to the river's large silt load, maintaining access to the industries requires that the Duwamish be periodically dredged for navigational purposes or otherwise improved. A number of industries discharge treated and some untreated wastewater effluent into the waterway. At the estuary's uppermost point near Tukwila, secondary sewage from Metro's Renton plant is discharged at a current rate of approximately 28 mgd (43.3 cfs) with expected increases of 72 to 99 mgd (111.3 to 153.1 cfs) by the year 2005 (Metropolitan Engineers, Facility Plan, 1977). The Duwamish River estuary also receives 251 million gallons of combined sewer overflows annually. Fisheries concerns are based on the migration of commercially important anadromous salmonids: chinook, coho, and chum salmon; plus steelhead, rainbow and cutthroat trout, all of which are residents. This river system is one of the most important spawning and rearing habitats for anadromous fishes in the Green River and Lake Washington drainage basins.

Water quality conditions in the Duwamish estuary are related to its uses and physical-chemical characteristics. Dissolved oxygen (DO) concentration in the surface water decreases downstream in the Duwamish. Washington State DOE Class B DO standards of 6.5 mg/l or 70% saturation for freshwater and saltwater, assumed to apply for both surface and bottom waters, are violated in July, August and September, corresponding to periods of low river flow and algae blooms. Low values (3 to 4 ppm) occur in the lower reaches of the river and are too low for many aquatic organisms. Low dissolved oxygen concentrations in the waters increase the toxicity of heavy metals, ammonia and other agents to fishes and other animals. The potential toxicity of the discharge from Metro's Renton sewage treatment plant is similarly increased by low DO conditions. This is expected to be a problem of greater magnitude in the future, as future flows from Renton may be one-third to one-half the river's flow under summer-fall conditions (Metropolitan Engineers Task D5, (1977).

Temperature standards (DOE Class B) are probably violated in summer months as the result of low flows, little shading along the river's bank and more intense sunshine (Metropolitan Engineers Task D5, 1977).

Variations in pH during a major algae bloom may be as high as one unit, exceeding the DOE standard set of 0.5 units of variation. Major blooms appear at least once every two years, influenced primarily by water salinity distribution, flow and turbidity (Welch, 1969).

The BOD (biochemical oxygen demand) in both bottom and surface waters is generally low, less than 4 mg/l, but increases to over 6 mg/l during algae blooms (Santos and Stoner, 1972). Blooms in recent years have been larger, causing aesthetic nuisance conditions.

Average nitrate concentration in freshwater has increased progressively since 1964 by amounts greater than those which can be attributed to the Renton treatment plant, 2.7 miles upstream from the station sampled (Santos and Stoner, 1972). Ammonia and phosphate concentrations increased significantly downstream from Metro's Renton plant outfall after the plant began operation in June, 1965, but concentrations of nitrogen and phosphorus were relatively high before operation of the plant and during nonbloom periods (Welch, 1969). Criteria for nitrate-nitrogen are violated regularly at Tukwila, and during high runoff periods at Auburn. Non-point sources appear to be involved at both stations, but Tukwila also received point source wastes (RIBCO, 1974). The Metro water quality staff has monitored water quality in the Duwamish and feels that Renton effluent is affecting nitrogen and phosphorus levels in the freshwaters of the upper estuary. In the dredged lower estuary, the effluent's effects are masked by the high nutrient concentrations in the salt wedge waters. Plankton blooms occur primarily in the lower estuary.

With increasing future flows from Renton, ammonia nitrogen is expected to exceed toxicity levels in the river by 1980 to 1990. The conversion of ammonia to nitrate in receiving water requires oxygen and thus contributes to dissolved oxygen depletion which may be as much as 2 to 3 mg/l by the year 2005. The RIBCO study which predicted the problem states that ammonia nitrogen should not be discharged to the estuary at the projected Renton discharge rates (RIBCO, 1974). Total coliform bacteria standards are violated throughout the river most of the year.

The Duwamish River estuary has been the site of at least one PCB spill. Recent preliminary measurements of toxic PCB's in sediment, algae and zooplankton are available for the Duwamish River and Elliott Bay from an analysis by EPA and the University of Washington Department of Oceanography (1973). Surface sediment concentrations of PCB's ranged from 1000 to greater than 2000 parts per billion (ppb). PCB concentrations in zooplankton exceeded criteria recommended by EPA.

Preliminary investigations to isolate the significant sources of PCB's were also conducted by EPA in 1973. Based upon measurements from the Renton plant and four interceptor flows, it was concluded that the major source of PCB's in the Duwamish River is some discharge other than those sampled. Recent Metro monitoring and field data on Renton plant discharge support this conclusion. Metro staff reports indicate high PCB's in a sewer overflow to the Duwamish, however.

This latter point is relevant as PCB's are suspected to cause fin erosion and liver disease in fishes, a common occurrence together with tumors and parasitic worm infestations in the Duwamish. Puget Sound Interim Studies investigations of these phenomena are discussed in the biotic sections of this report.

In summary, the Lower Green-Duwamish River is the most contaminated local body of water with respect to toxic substances. The river flows through a major industrial area of Seattle which is susceptible to toxicant introductions through direct discharge, non-point source runoff and accidental spills. The problem as it now exists in the Lower Green-Duwamish River is one of increasing levels of heavy metals and chlorinated hydrocarbons in bottom sediments and resident fish populations plus heavy metal and inorganic substances in the water. The concern is also for adjacent waters, as water and sediments from the Duwamish move north and west along the shore of Elliott Bay to West Point in a few hours (Figure 2-9).

THE BIOTIC ENVIRONMENT

Assessment of ecological communities in impact assessment documents is generally based on surveys of the distribution, diversity and abundance of organisms in the areas of interest. The observed patterns of distribution, diversity and abundance are the result of complex natural selection pressures: inter- and intraspecific interactions, predation, food availability, physical-chemical environmental conditions, and chance. To understand the observed patterns requires a systems approach, an understanding of the interrelatedness and balances of the components of an ecological community. Therefore, knowing merely the physiological tolerance limits of the organisms found in a given area is not sufficient to predict the impact of a perturbation due to human activities. Unfortunately, the state of ecological knowledge is such that for most communities the requisite information is not available.

A further and equally important consideration is adequately sampling an area such that abundance and distribution can be determined at all. Aquatic systems, with the possible exception of the intertidal and small bodies of water, present especially difficult and unique problems. Due to the lack of direct access to the organisms, the scientist is generally forced to rely on unwieldy sampling devices operated from the surface, in the absence of direct information on the organisms below, their reaction to the gear, and on the field efficiency of the gear. Also, natural patchiness in the distribution of most organisms creates high sampling variability. All of the above are critical to determining sampling error. The use of sonar detection methods has somewhat mitigated these problems, but is not in widespread use. It remains, therefore, more difficult to balance sampling adequacy against cost in aquatic than in terrestrial studies.

The Puget Sound region is biotically diverse and comprised of a variety of natural and modified habitats: urban terrestrial areas, forests, non-forest terrestrial vegetation, wetlands, intertidal areas, freshwaters (ponds, lakes, rivers, streams), saltwaters (Puget Sound), and estuarine waters (Duwamish). Each habitat is characterized by a set of physical and chemical conditions, flora and fauna.

A discussion of natural succession would provide a basis for describing the biological environment that would exist in the future without implementation of the proposed action. However, successional data are sparse, at best, for the various biotic habitats in the study area.

Existing Environmental Conditions

Terrestrial Habitats

The fauna of terrestrial habitats generally correlates with vegetation whose distribution is, in turn, tied to soil characteristics, moisture and light conditions. Heterogeneous vegetation creates greater faunal habitat diversity through its structural and food resource diversity. Small areas of diverse vegetation may lack certain species, however, which require large foraging areas, territories, or corridors for migration or are more disturbed by the presence of man. The activities of man dominate the study area and have left most terrestrial environments in a highly modified state. Paving and the planting of crops and ornamentals have largely replaced the original forest and shrub. Natural floral assemblages remain in patches in the Metro area and in large portions of the eastern Puget Sound region (Metropolitan Engineers, Tasks A1G and B5F, 1976).

Nonvegetated areas include heavily developed urban areas such as some Duwamish or Interbay (the Commodore Way site) sites considered in some alternatives. Nevertheless, some organisms thrive in these otherwise inhospitable environments. Scavenging birds such as pigeons (rock doves) and sea gulls have also adapted to urban settings. Rock doves nest in buildings while gulls nest near shore and fly to city feeding areas daily. Other urban animals include rats, mice, beetles, flies, ants and other pest species.

The vegetation of city green belts, empty lots, undeveloped ravines, neighborhood parks, highway rights-of-way and residential areas tends to be fairly homogenous and thus supports few species of animals. Lawns and ornamental trees support robins, sparrows, swallows, migratory passerines, squirrels, wild rats and mice, and a host of insects. Greater varieties of animals such as the California quail, rufous-sided towhees, sparrows, lizards, and toads live in thickets of Himalayan blackberry, salmonberry, and other shrubs which provide more food resources and shelter from predators. Parks may have, in addition, rabbits, raccoons, weasels, and a number of migratory and resident birds. Portions of Alki, West Point, Carkeek Park, Richmond Beach, Interbay (the Golf Park site) and some Duwamish sites are representative of this habitat.

Forested areas occur near West Point (Discovery Park), Carkeek Park, Richmond Beach, the University of Washington Arboretum and grounds, and the eastern border of the study area. Primary trees include Douglas fir, western hemlock, western red cedar, red alder, deciduous big leaf maple, willow and black cottonwood. The composition of the forest understory usually is comprised of a combination of young trees, shrubs, forbs, grasses, ferns and mosses. Mixed deciduous-coniferous forest offers the greatest environmental diversity and thus supports the richest animal assemblage. The vegetative cover of the meadow-like lowland areas is primarily grasses interspersed with scattered stands of fir. Beaver, muskrat, mink, and river otter occur along lowland water courses. Raccoon, opossum, red fox, weasel, and skunk inhabit valleys in the area and are relatively unperturbed by humans. Coyotes and bobcats also can exist with man but prefer wooded foothills. Squirrels, marmots, and chipmunks are common. Game birds include grouse, pheasant, partridge, quail and doves. Raptors include a variety of owls and hawks. Finally, there is a diversity of songbirds and "pests" such as crows, sparrows and starlings.

Shoreline Habitats

Of the Puget Sound region's fauna, the most important to this analysis are water-associated. Marshes and estuaries are important for habitat, food and propagation of a large number of birds, mammals and amphibians. Past land development, which included drainage and fill or flooding through levees and dams, has reduced the availability and extent of these ecosystems. Increased nutrients entering these waters have encouraged the growth of algae and shoreline vegetation which have also altered the composition of aquatic communities.

The physical and chemical characteristics of these waters have been described in earlier sections of this chapter. A description of the biological, ecological and environmental characteristics is offered of the historical condition (if known), the present conditions and projections to the year 2005.

Shoreline habitats - freshwater marshes, salt or tidal marshes and the intertidal itself - have certain important characteristics in common. For example, they support a variety of migratory and resident water birds that rely on the area for either food, breeding grounds or both. These habitats are more sensitive to changes in the physical and chemical characteristics of the land immediately adjacent than are open waters. Dilution of runoff is limited in the shallows, particularly in areas where circulation is slow. Wetlands also tend to be highly productive. Vegetation is generally dense, characterized by heavy growths of saltgrass and pickleweed in tidal marshes as well as cattails, rushes and sedges in freshwater marshes. Major groups of birds include mallard, pintail, coot, goldeneye, teal, widgeon, grebes, scoters and several species of geese.

A number of species of gulls and wading birds (such as herons and cranes) are common. In freshwaters these birds feed on fishes, insects, frogs, and various plants; in salt-water areas, common prey include fishes, fish eggs, crustaceans, mollusks and other marine invertebrates. A number of birds also feed on dead or dying salmon and salmon eggs. Crows and gulls tend to be scavengers but, like owls and hawks, prey upon the chicks of other shore birds, sometimes seriously reducing their prey's population. Shellfish beds can be damaged by scoters (white-winged, surf and black species) when the birds are abundant, so that limited hunting of these species is encouraged (Salo, 1975).

By contrast, some of the water birds need protection since they are limited in distribution. For example, the black oyster-catcher is restricted to rocky intertidal areas and the black brant (a goose) feeds only in eelgrass and sea lettuce (Ulva) beds. To ensure protection of these water birds, their food source and substrates should be protected.

The distribution of wetlands and wildlife in the study area is summarized in Appendix Figure D-1. None of the alternative plant sites contain this type of habitat, but a number of combined sewer overflow points infringe on wetlands. Kellogg Island in the Duwamish has a small saltwater marsh. Lists of terrestrial and marshland fauna of the study area are given in Appendix Tables D-2 and D-3.

Intertidal Habitats

The intertidal zone is that area which, lying between the high tide and low tide levels, is submerged at high tide and exposed at low tide. The tideland habitat along much of central Puget Sound has been highly modified through time by dredge and fill operations. Natural shoreline in the Seattle area is limited to Meadow Point, the north and south sides of Magnolia Bluff, a small area north of Alki Point and just south of Brace Point. Disturbed shorelines nevertheless support well-developed biota. Rock-cobble substrates, sand-gravel, and muddy silt-and-sand soft bottoms each have a characteristic flora and fauna.

Intertidal areas are examined in detail herein since they are frequently visited by the public and may be subject to contamination from several types of nearby sources. With the exception of West Point's north and south beaches, the beaches near the Metro facilities along Puget Sound are used by sport clam diggers. Alki, Carkeek Park and Lincoln Park beaches are visited by numerous school children on field trips throughout the year. Three potential sources of contamination in the intertidal have been examined: (1) the four Metro wastewater treatment plants, (2) combined sewer overflows, and (3) groundwater seepage. Shoreline fill in some alternatives is also of concern in the intertidal.

Existing Environmental Conditions

The impacts noted to date on biota in the intertidal generally fall into three distinct groups. First, the overall input from the sources described above has apparently produced some changes in community structure such as altered abundance, diversity and biomass that cannot necessarily be attributed to a specific contaminant or source. Second, the effluent discharge and combined sewer overflows have possibly tended to influence heavy metals concentrations. Third, the levels of pathogens and toxicants are being investigated for potential impacts on intertidal biota and human consumers of shellfish. Each of these three types of impacts in the existing environment are discussed further.

General Changes in Community Structure

Some existing influences on the intertidal have been claimed. The dye studies at West Point, described previously, indicated that effluent may surface at West Point beaches in summer when the water column stability is high. Intertidal benthic forms may thus have periodic contact with effluent at a dilution about half that at the diffuser (250:1). A similar phenomenon is likely at Alki, where initial dilution is only 10:1, and at the other plant sites due to onshore currents (Metropolitan Engineers Facility Plan, 1977). Eastern central basin beaches are also subject to other discharges such as combined sewer overflows. In addition, there appeared to be a seepage of odoriferous groundwater into the West Point north intertidal area, which may have an effect, especially at low tide, by introducing sulfurous, low dissolved oxygen and low salinity water into the intertidal.

The biota on the four beaches near the outfalls and at Lincoln Park have been monitored in a biannual intertidal sampling program established by the University of Washington College of Fisheries in 1971. To date, no significant differences between number of animal species, natural history, biomass or seasonality of animals have been found.

Seasonality and between-beach differences were observed in intertidal benthic algae at the same five sites, however. Differences in species number and frequency were attributed primarily to availability of suitable substrate. Comparison with other areas in Puget Sound showed that Seattle beaches tend to have greater numbers of green and blue-green algae than brown algae, the reverse of the situation elsewhere (Whidbey Island, Steamboat Island and Hood Canal). It was also noted that the total biomass of algae was greater in 1973 than in 1971. The increase was not quantified. The 1975 data suggest that changes that have occurred since the 1973 study are comparable to those described above (Armstrong *et al.*,1976).

Nutrients are postulated to affect the growth and reproduction of a common brown alga, Fucus. The present studies indicate that a positive relationship exists at West Point between amount of sewage effluent present and formation of reproductive structures. The macroalgae or large "kelp" species, Laminaria and Nereocystis, have significantly higher and lower growth rates respectively at West Point, and the kelp bed community in general is less diverse.

The intertidal at West Point also has fewer species of diatoms (single-celled plants) than the other sites, and significantly greater growth of limpets, mollusks that graze on diatoms. Limpet growth rates may be related to the change in diatom community. The diversity of diatom assemblages has been shown repeatedly to be inversely related to levels of pollution (Patrick, 1949; Hohn, 1959).

A pattern of increased biomass, reduced species numbers and greater abundance of green and blue-green algae could indicate a developing nutrient enrichment situation, a chronic stress on the system which is difficult to assess. The stress, by worker's best estimates (Thom et al.,1977), is from sewage. This parallels the situation in freshwater, in which green and blue-green algae predominate where sewage effluent, septic tank overflows, and other sources of high nutrients, such as fertilizers, gain entry to the water body. Increases in effluent flows and/or CSO's in the future could intensify the situation.

Combined sewer overflows are another source of potential pollutants in the intertidal. There are twenty-two such discharges into Puget Sound and Elliott Bay, many near swimming beaches and a few in shellfish areas. Recent dye studies indicate that areas along the shore, including the intertidal, have markedly slower rates of circulation and lower dilution capacities than do offshore areas. Nearshore waters also tend to move strongly along the shore in either direction contrary to the direction of the prevailing tide or current until reaching an exposed point where they move outward into the prevailing surface current and sink. Depending on flows and the concentrations of water quality contaminants, the potential impacts on the intertidal from combined sewer overflows could be substantial.

While combined sewer overflows are widespread and of long-standing concern, little is known of their quality or their effect on receiving waters and biota. Metro water quality staff studied two August 1976 storms at each of four important overflow sites (Tomlinson et al., 1976): the Denny Way regulator (WO27) emptying into Elliott Bay, the Hanford regulator (WO32) in the East Waterway of the Duwamish estuary, Madison Park (023) on Lake Washington and Roanoke Street (132) on Lake Union. No macroscopic biota were found at the freshwater stations, Madison or Roanoke. Similarly in the intertidal at Hanford, no biota were found in the plume area; numerous worms were found outside the plume. Denny Street had abundant worms of species associated with disturbed areas, plus some clams, crabs, amphipods and other worms. From these preliminary data, the overflows appear to be having a substantial adverse impact on intertidal biota in the vicinity of the overflow point. The extent of the effect is unknown. A summary of the study is given in Appendix Table D-4.

The substantial variation in quality of overflows and in circulation at the four sites prevents generalizing to the entire overflow system. Overflow locations are well known and approximate annual flows have been estimated (Figure 2-7), but their effects on habitats have not been evaluated.

Other minor sources of pollutants to the intertidal and nearshore waters are septic tank seepages. Septic tank effluent from Lawtonwood, an unsewered residential area comprised of about two dozen houses, enters a small stream running from Fort Lawton down to the shore of Puget Sound, just north of West Point. Septic tank effluent also enters the intertidal at Perkins Lane at the base of Magnolia Bluff and in the Salt Water Park area south of Seattle. The Seattle-King County Health Department recommends that no shellfish taken from these beaches be consumed (Seattle-King County Health Department, personal communication, 1977).

Heavy Metals

Treated sewage as a mixture from both industrial and domestic sources carries materials including heavy metals that can impact and be assimilated into biota. Trace metals in water incorporated into biota can be further concentrated selectively into body tissues. Once the elements enter the food web, predator-prey interactions pass these materials on, with subsequent concentration in the predator's organs. As man is a predator in this process, it is important to examine the trace elements and other toxicants that could affect a seafood consumer.

Levels of metals are thought to be (1) generally low, at least in West Point effluent for which data is available, (2) probably somewhat correlated with rainfall, and (3) generally within NPDES effluent limits. It is known, however, that a slug of mercury, chromium or arsenic of unknown source occasionally goes through the plant. Proposed EPA criteria for marine and freshwaters are shown in Appendix Table D-5.

A discussion of toxicants in the study area can be found in Metropolitan Engineers Task Report D3, "Preliminary Environmental Evaluation" (1976).

The distribution of heavy metals in intertidal biota of central Puget Sound has been examined (Olsen, 1976). The data suggest (Schell _et al._, 1977) that levels of metals tested, except arsenic, are higher in intertidal organisms at Metro outfall areas than in central areas, but the statistical significance of these data is not determinable. The study did show that _Ulva_, a green alga, tended to concentrate lead and that clams and mussels were able to concentrate all elements studied. Levels of mercury, however, were below FDA standards: Federal Food and Drug regulations prohibit the sale of shellfish and fish containing mercury levels greater than 500 parts mercury per billion parts wet weight (ng/g). Allowable levels for other metals have not been fixed. Concentrations of lead in clams were on the average 62 percent higher on the north side of West Point than at the other five stations. Mercury levels in clams were highest at West Point (north side) and at Carkeek Park, followed by levels found at Lincoln Park. Data on other metals and other intertidal organisms tested indicated that, in general, metals at West Point were slightly, but not significantly higher. Plankton contained significantly higher concentrations of copper and zinc in the vicinity of Metro sewage outfalls, however (Olsen, 1976).

Levels of certain metals in biota near the Denny Street overflows are shown in Appendix Table D-6. Levels of lead in clams 100 yards south and 30 yards offshore were two orders of magnitude higher (parts per million or mg/kg dry weight), than in intertidal clams at West Point's south beach.

Pathogens and Toxicants

Important water quality contaminants other than metals which may be concentrated by shellfish consumed by humans include pathogens, but levels in shellfish from these areas are not now monitored. Metro water quality data indicate that the water at these beaches meet total but not fecal coliform bacterial standards for commercial shellfish waters. Bathing standards are regularly met (Seattle-King County Health Department, personal communication, 1977).

Toxic elements are not regularly monitored by Metro or any other agencies in the study area, but Metro plans to do so beginning in 1978. Special PCB studies performed by Metro staff indicated very low levels in effluents with routine monitoring.

Existing Environmental Conditions

Puget Sound

The area of study is the central basin of Puget Sound from Mukilteo in the north to Poverty Bay, the marine boundary of the Cedar-Green River drainage basin in the south. Puget Sound is characterized by high levels of ecological activity, floral and faunal productivity. Productivity is enhanced by nutrients from upwelling of oceanic waters, freshwater nutrient contributions, and sunlight to shallow waters. Other inputs to Puget Sound, such as municipal and industrial effluents, runoff, combined sewer overflows and aerial contaminants have been discussed in previous sections of this report. The ecological relationships of Puget Sound are complex, partly because of the physical-chemical variables such as currents, tides, winds, temperatures, quality and quantity of inflows and contaminants. These parameters affect dilution, dispersion, light intensity, salinity, pH, dissolved oxygen and other chemical and physical factors on which plankton and other aquatic life depend. In general, however, the biological communities are productive and diverse. Estuaries, such as Puget Sound, also serve as nurseries for a number of aquatic organisms, providing food and shelter for embryonic, larval, juvenile and adult life stages. Early life stages are especially sensitive to environmental conditions.

To evaluate impacts of the various alternatives it is necessary to understand the complexities of the existing estuarine habitat and its organisms. Comprehensive understanding of Puget Sound, like other aquatic ecosystems, is limited at best, due to the dearth of basic ecological knowledge. Several of the Puget Sound Interim Studies (PSIS) and other reports have addressed themselves to the biology of the Sound as affected by man-made inputs. The intertidal portion of the studies have been described previously, and the general biological characteristics of Puget Sound have been described in the "Puget Sound Regional Assessment Study" of June 1975 (Vol. II Supplement) in terms of species composition lists, figures on numerical abundance, biomass and production for the producer, consumer, and decomposer trophic levels.

Primary Productivity

In general, phytoplankton populations are found to be viable throughout the water column; indeed, greater numbers of cells are found below the euphotic or lighted zone, probably carried to depth by turbulence at the Admiralty Inlet Sill. Evaluations of phytoplankton productivity and standing stock in central Puget Sound were part of the Puget Sound Interim Studies.

The annual cycle of algal growth, dominated by a series of intense blooms beginning in early spring and recurring throughout the summer, is limited primarily by inadequate sunlight in winter and other factors. Growth is also limited by vertical movement and turbulence, changes in light intensity due to self-shading and particulates, sinking of algal cells and occasional rapid horizontal movement of cell populations by sustained winds during spring and autumn.

Phytoplankton growth is rarely limited by nutrient depletion. Phosphate always occurs in excess of need; short-term nitrate depletion (3-4 days) concurrent with the most intense blooms has been observed in earlier studies. Zooplankton grazing appears to be unimportant in controlling natural phytoplankton blooms in Puget Sound (STR, 1975).

Phytoplankton patches sampled in the Seattle area apparently originate at two locations: (1) at the edge of the Puyallup River plume at Tacoma from which patches move forward through the East Passage and (2) a bloom system off Seattle near Restoration Point (across from Alki). Patches are carried northward and out of the Sound over the Admiralty Inlet Sill and are mixed downward into waters moving landward by vigorous tidal action. Cells may be returned to the photic zone by turbulent motion upwards and upwelling by tidal mixing at the Tacoma Narrows in about ten days (see Appendix Figure D-2). The entire cycle takes about three weeks, such that there are about seven cycles from April to August. These cycles are felt to be important to Puget Sound primary productivity, especially in May-June and July-August.

Productivity is significantly lower in Elliott Bay than in mid-channel due partially to limited light penetration resulting from the silt load carried in by the Duwamish River.

The only significant longitudinal variation in the central Sound attributed to the West Point outfall is a 15-20 percent increase in the 1, 2, 3, 5 and 10 year extreme values at stations within a mile north and south of the outfall. The effect of the effluent is felt to be reduced by the effluent's equilibrium depth being below the depths of maximum productivity (see Appendix Figure D-3, Ebbesmeyer and Helseth, 1976). In addition, dilution to background levels of most effluent patches is thought to occur in six to twelve hours, significantly less time than the one day usually assumed for phytoplankton to divide. Under bloom conditions, however, doubling time may be only eight to ten hours (S. Campbell, personal communication).

The other major group of plants in Puget Sound are the benthic algae which occur subtidally and intertidally. Intertidal algae have been described in a previous section of this report. Subtidal kelp beds provide an important and diverse habitat for a number of fishes and marine invertebrates. Subtidal algal species lists are available; abundance and biomass data generally are not. An important habitat at low tide and subtidal levels is created by beds of eelgrass (Zostera), one of the few marine flowering plants. A host of larval and adult fishes, invertebrates and marine birds are associated with these areas. Eelgrass beds are found at Alki, Lincoln Park, Point Pully, Carkeek and elsewhere (Department of Fisheries; McGreevy, 1973). Like the intertidal species at West Point, subtidal forms are occasionally exposed to effluent at concentrations about half those at the diffuser or higher.

Zooplankton and Pelagic Fish

Pelagic fish and zooplankton were evaluated by acoustic tracking as part of the Puget Sound Interim Studies. Zooplankton, small animals that feed on algae, form a food base for many species. Zooplankton and fishes occur in patches and may be distributed by strong tidal currents as well as by their own movements. The cycle of abundance of juvenile herring was found to be responsible for the observed overall high fish densities in September and low densities in February (Miller et al.,1976). Central basin littoral (nearshore) areas may be an important nursery and spawning area for herring. Herring eggs are sticky and adhere to eelgrass, rockweed and other seaweed, rock, pilings, or trash. While juvenile herring are not excessively preyed upon, later stages and adults form one of the major foods of the sea, the prey of chinook and coho salmon, water fowl, sharks, sea lions and whales (Hart, 1973).

No particular evidence in the data collected indicated a change in fish populations with the sample locations (West Point, Alki Point, Point Williams). The scatter in data, due to geographical patchiness and temporal variations, precludes any such finding at this time.

Fish eggs and larvae were also sampled at sites close to and distant from West Point and Alki Point outfalls. No patterns of distribution other than seasonal and depth were detected in the central Sound. No discernible attraction to or avoidance of the outfalls was evident, but currents are more powerful than the swimming motions of most of these organisms.

Benthic Organisms

The distribution, properties and microbiological components of bottom sediment and the macrofauna in the central basin of Puget Sound have been investigated. In some cases, distribution patterns are related to the West Point and Carkeek discharges inasmuch as an abundance or a reduction of a biological component appears uniquely related to the typical horizontal and vertical plume position near the 150 foot contour. Some benthic populations (clams, marine worms) were usually large at the 150 ft contour. The distribution of the foraminiferan, *Buliminella elegantissima* also appears to be related to the West Point plume. This species, found to delineate areas influenced by sewage outfalls in Orange County, California, has also been found in Puget Sound shallow water habitats having high organic content and accumulation of fine debris (Harmon *et al*., 1976; Duxbury, 1976).

At about this 150 ft level is an abundance of marine life and organic debris accumulation with high diversity within a few groups of organisms. Substrate differences at this intermediate depth, sulphurous and organically rich sediments related to the old sewer outfall at West Point, are present and also influence the distribution of organisms. The areas sampled did not include the Richmond Beach and Alki areas. Due to the sampling design of this study, quantitative differences and statistical significance of observed trends could not be determined.

Demersal Fishes

Demersal, or bottom-dwelling, fishes in the study area were sampled at West Point, Alki and the Duwamish River as part of the Interim Studies. Substantial differences in nearshore species composition, abundance (standing crop), frequency of occurrence,and species richness between West Point, Alki Point, and Point Pully (control) are highly correlated with habitat or substrate variation between sites, and there is no evidence at this time that "wastewater discharged into Metro facilities has adversely impacted nearshore shallow water fishes" (Miller *et al*., 1976).

Juvenile coho and chum salmon occurred more frequently at West Point, especially in spring when the fish feed heavily on nearshore invertebrates. While salmonids are temporary members of the nearshore community, they may be adversely affected by (1) wastewater brought into shallow waters by eddy systems, or by (2) congregating around the outfalls. The fish could be potentially impacted through accumulation of toxic materials from nearshore prey species or by direct contact with toxic wastewater from the outfall.

Offshore sampling revealed important differences between the control and the two outfall sites in terms of frequency of occurrence of dominant species, recurrent species groups, species richness and diversity, especially in deeper water. "While no direct cause and effect relationship can be demonstrated at West Point, the evidence thus far suggests that the deep water fish community there may have been altered by the discharge of wastewater from the Metro facility" (Miller et al., 1976).

Differences at West Point include higher standing crops (catch per haul), a high abundance of ratfish, a reduction in both diversity and evenness and the apparent replacement of slender sole by rex sole. The significance of this replacement is in the feeding modes of the two species. Slender sole feed on bottom-living free swimming crustaceans (shrimps, crabs, etc.); rex sole feed on benthic infauna, polychaetes (worms), clams, and the like which live in bottom sediment. The replacement may indicate a change in the benthic community, perhaps in the form of a higher standing crop of benthic infauna. While these differences may be due to natural variation between sites, it is also possible that the changes are associated with the West Point effluent discharge.

Studies elsewhere (SCCWRP, 1975; Smith, 1976) have shown that organic enrichment of benthic communities by sewage and/or sludge usually results in an increased abundance of biomass of infauna, a lower species diversity and substantial change in species composition. Substantial biological changes at a new outfall can occur unaccompanied by any measurable adverse changes in sediment or water quality. An increased abundance of the fish which use bottom sediment dwellers the most as prey, such as rex sole, occurs. In Southern California, dover sole are attracted to the Orange County outfall area.

The benthic environment near West Point is still not well understood. Domenowske and Matsuda (1969) found no sludge buildup or change in the abundance of some benthic organisms near West Point, which went on line in 1966. Subtle changes in the benthic community may have occurred which were not readily discernible. The study discussed above (Harmon et al., 1976) indicated a change in the benthos and increased abundance of infaunal species at the 150 ft contour but the data were judged inconclusive (Stober, personal communication, 1976).

A portion of the fish study was designed to establish relationships between the occurrence of disease or parasite infestation near the sewage outfall. Skin Tumors (epidermal papillomas) were found on flatfish at all sites, but incidence ranged from 3.3 to 18.4 percent of the sampled fishes with an average of about 14 percent at West Point, 3 percent at Alki and 10 percent at Point Pully. Of Duwamish fishes sampled (starry flounder) an average of 18.6 percent were tumorous with a range of 11 to 37 percent depending on the season. Studies of tumors at the subcellular level revealed no bacteria or fungi, but virus-like particles were observed. A certain incidence of skin tumors would probably exist in the absence of man. The question is not the presence or absence of tumors, but what level of disease indicates disturbance to the system. Determining a background level is nearly impossible as natural conditions in the Sound are highly variable and domestic and industrial effluents enter its waters at many points inside and outside the present study area. Other studies suggest, however, that the incidence of disease and parasitism increased with crowding, especially if bacteria or viruses are involved. Any area where fish congregate, such as at an enriched infaunal area often found near outfalls, would likely show increased disease incidence from increased contact between fishes and perhaps with pathogens or toxics in sewage effluent.

Philometra americana (blood worm), an external nematode parasite, was found on English sole and rock sole in varying frequencies: 7 percent at West Point, 16 percent at Alki, and 21 percent at Point Pully, the control area. In the Duwamish, the average was 11 percent. Infested fish were all larger than 6 inches and the parasite did not appear on any smaller fish. The life cycle of this species of Philometra is undocumented, however. No attempt is made in the report to relate this disease to the impacts of man on the Sound. Increasing infestion to the south suggests that flushing in those parts of the Sound may be insufficient to disperse waterborne disease causing agents, whether of human or "natural" origin (J. McDonnell, personal communication, 1977). There appears to be a trend of increasing levels of infestation to the south in Puget Sound.

The disease studies have inherent uncertainties. Point Pully is flanked to the north and south by two sewage discharges, Miller Creek and Salmon Creek, so its use as a control may be unrealistic. Finding a suitable control in Puget Sound may be an equally unrealistic goal, however. In addition, trawl estimates of fish biomass have been shown to be two orders of magnitude less than visual estimates by divers at similar sites (Smith, 1976).

Effluent Quality: Toxicity Versus Public Health

Where potential public health hazards and adverse impacts on aquatic environments both exist, the question of effluent disinfection versus effluent toxicity arises. Chlorine is presently the most widely used and least expensive method of disinfection of wastewaters. Chlorine dose required varies with waste treatment employed. As a rule of thumb, if the required chlorine dose for adequate disinfection (bacterial removal) of average strength primary sewage is 15 mg/l, waste treated by chemical precipitation would require about 2/3 as much and by activated sludge processes about half as much to achieve the same level of disinfection.

Coliform bacteria are the indicator organisms for public health and disinfection efficiency in marine as well as freshwaters. Coliform standards for a given body of water depend upon the uses of that water, the applicable standard being that for the most sensitive beneficial use. Under State of Washington water quality standards, Puget Sound is classified AA Extraordinary and carries a median total coliform standard (MPN 100 ml) of less than 70, with not more than 10% of the samples greater than 230/100 ml. These standards meet U.S. Public Health Service criteria for shellfish waters.

Shellfish have long been implicated as carriers of typhoid fever and other enteric diseases, plus infectious hepatitis. This is potentially of concern as hardshell clams and geoducks occur on beaches at or near Carkeek Park, south of West Point, at Alki, and near Richmond Beach (Figures 2-16 and 2-17). Moreover, unlike other marine foods, these organisms are frequently eaten raw or partially cooked. Studies have shown that Salmonella bacteria and enteric viruses do occur in shellfish and shellfish-growing waters judged to be sanitarily acceptable by fecal coliform standards (Metcalf, 1974). Bacterial indices are of questionable usefulness when applied to sanitary assessments involving shellfish subjected to low levels of fecal pollution, especially for enteric virus. Viruses have been shown to enter the marine food chain, including edible species of fish and shellfish. In addition, pathogens adsorbed into particles which settle fairly rapidly are not quickly killed, but remain infectious for long periods of time; a potential problem if the sediments in which they reside are resuspended by tide or wave action or other turbulence.

Coliform effluent limitations for Metro's treatment plants are shown in Appendix Table D-7. For the six months of April through September, the percentage of Metro monitoring stations with median counts in excess of total coliform standards are shown in Appendix Table D-8. Violations occur most frequently in the shoreline vicinity of the outfalls from Carkeek Park, West Point, and Alki (Metropolitan Engineers, 1976). Metro shoreline monitoring data for the six-month period of April through September 1976 indicated that beaches near Metro's outfalls in general did not exceed total coliform standards. Median standards were violated at Carkeek, the Ship Canal, and the Harbor Island area at the mouth of the Duwamish. Special study programs have been initiated at all three sites by Metro Staff. Fecal coliforms accounted

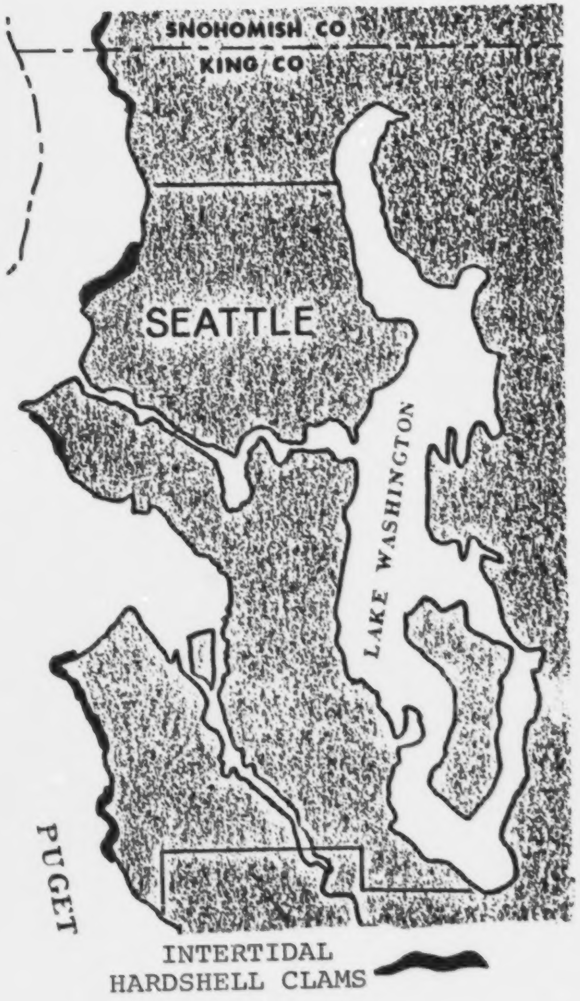

SNOHOMISH CO
KING CO
SEATTLE
LAKE WASHINGTON
PUGET
INTERTIDAL HARDSHELL CLAMS

FIGURE 2-16

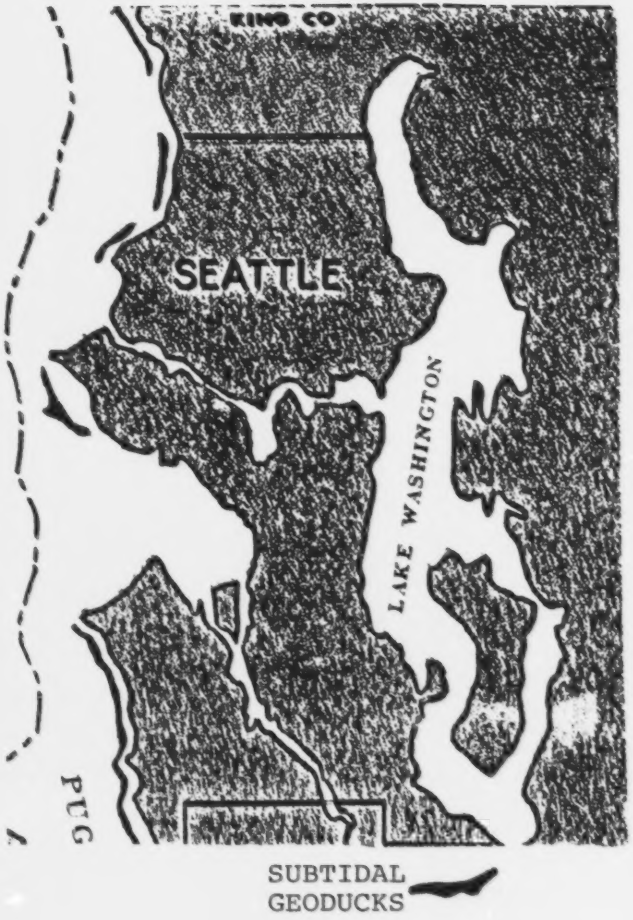

KING CO
SEATTLE
LAKE WASHINGTON
PUG
SUBTIDAL GEODUCKS

FIGURE 2-17

for most of the median total coliform levels found. At beach stations, maximum values were of either fecal or nonfecal origin. Median MPN fecal coliform at Puget Sound beaches averaged about 20/100 ml but tended to be higher at Carkeek.

The Washington State Department of Social and Health Services monitors shellfish areas for both fecal and total coliforms, mercury and paralytic shellfish poison. The department has no jurisdiction over sport shellfish and there is no commercial take in the Metro area. Bacterial standards applied by the department for shellfish waters are fecal coliform median MPN of 14/100 ml with no more than 10% of the samples over 43/100 ml. Virtually all of the Metro Puget Sound beach and offshore stations failed to meet the State fecal coliform standard for commercial shellfish waters in 1976. This suggests that consumers of shellfish dug on beaches in the Metro area are exposed to greater risk of disease than is allowed for commercial shellfish. The source(s) of the bacteria has not been identified.

The toxicity of sewage effluent to organisms in receiving waters has recently received attention (Brungs, 1976). Studies have dealt primarily with effects of chlorine, but also with secondary products formed such as chloramines and chlorinated hydrocarbons, and with heavy metals and pesticides. Acute and chronic bioassay experiments have been performed at West Point as part of the Puget Sound Interim Studies (Stober et al., 1976 and personal communication, 1976). Toxicity studies by Metro indicate that the salmon 96 hour LC 50 (concentration which kills 50% of test animals after 96 hours) for primary effluent averages about 7.5 percent effluent and that chlorine and chloramines are the principal toxicants at about 0.07 mg/l total residual chlorine. Sublethal effects can occur at far lower levels, however. "Safe" levels are suggested at 0.1 times the 96 hour LC 50 concentration (an average of 0.75 percent primary effluent in this case (NTAC, 1968). Effluent of twice the dilution at the diffuser (250:1 or 0.4 percent effluent) appears at West Point beaches. The frequency, distribution and duration of this phenomenon is presently unknown, but it appears that variable conditions may intermittently expose juvenile salmonids and other species to toxicants at close to limits for safe levels on the average, but which commonly exceed those levels. Deep water food fishes which migrate into shallow waters off West Point and Alki at night to feed may be similarly exposed.

Appendix Table D-9, which gives toxic levels reported for various marine organisms, indicates that chlorine can apparently be detrimental to aquatic organisms at low levels (Brungs, 1976). Proposed U.S. EPA criteria (1975) are 0.002 mg/l for salmonid fishes and 0.01 mg/l for marine and other freshwater organisms continuously exposed. Actual chlorine residual in Metro effluents from Alki, Carkeek Park and Richmond Beach is uncertain as chlorine feed rate is manually controlled and mixed in the outfall pipe. There are no changes in feed rate with seasonal or daily changes in flow. Chlorine feed rate is residual paced at West Point, but peaks in residual chlorine are not uncommon. In addition, the residual is measured a short distance downstream of the chlorine feeding point and therefore does not reflect the actual chlorine residual before discharging into Puget Sound.

Calculated total residual chlorine at the West Point diffuser is 0.008 ± 0.002 mg/l on the average. Peaks of 0.02 mg/l are common and occurrences of 0.036 mg/l are occasional (Stober et al., 1977). The average value is the limit for safe levels of 0.0075 mg/l (0.1 x 96LC50). Exposure is intermittent, however, and no acute or chronic toxic effects have been verified in the field to date.

There is a growing sentiment that alternate forms of disinfection to chlorination be emphasized to protect aquatic life. Recent studies (Marine Research, 1976; R.K. Kawaratani, personal communication, 1977) have shown that halogenated organics, specifically haloforms, occur in approximately the same concentrations after disinfection of power station cooling water(saltwaters) with chlorine, bromine, ozone, or hydrogen peroxide. Haloforms and halogenated organic pesticides can be bioconcentrated with adverse results. For example, DDT in an initial concentration of three parts per trillion in seawater was concentrated 25 million times (to 75 ppm) in a four-step chain causing reproductive failure for the top carnivore (Baalsrud, 1974).

Levels of these compounds in Metro sewage effluents and combined sewer overflows are not well known, nor are the effects of chronic exposure in Puget Sound. Recent reviews of the effects of organic residues and of heavy metals in marine environments are given in papers by Portmann (1975) and Jernelöv (1975).

Commercial and Sport Fisheries

Commercial marine shellfish and invertebrates include dungeness crabs; butter, horse, and manila clams; geoducks; cockles; mussels; squid, shrimp; octopus; and oysters (the introduced Pacific oyster). Anadromous (migratory) and resident fishes are valuable resources in the Puget Sound region. The most important are the five species of Pacific salmon -- chinook, coho, sockeye, chum and pink -- plus steelhead, searun cutthroat and dolly varden trout. Saltwater commercial and sport fish include lingcod, Pacific cod, sole or flounder, rockfish, surf perch, smelt, herring, dogfish and ratfish. The distribution of commercial and sport fisheries in the study area are shown in Appendix Figure D-4 (Washington Marine Atlas, 1972).

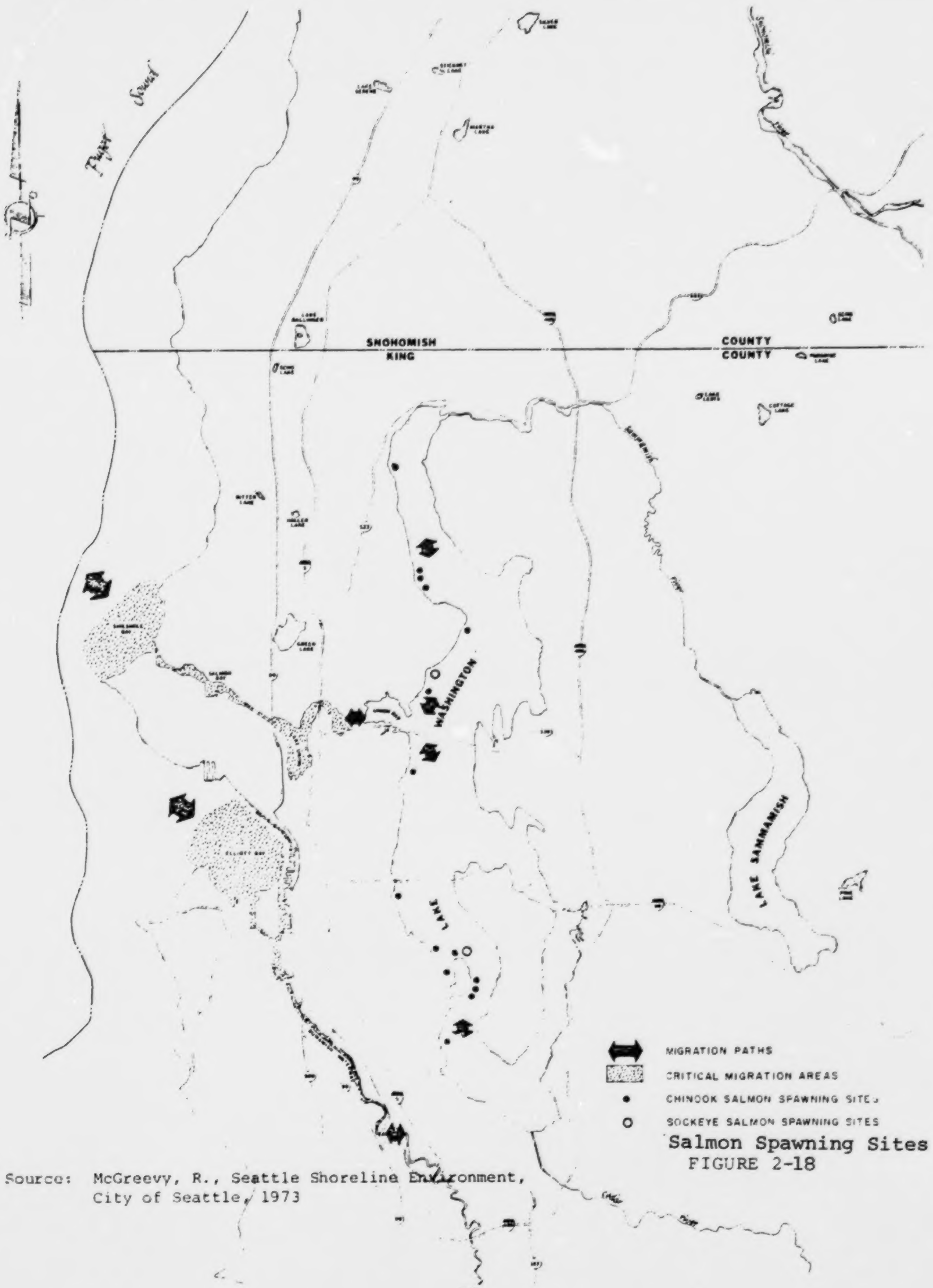
Salmon spawn in a variety of locations in the study area (Figure 2-18). The Green River and its tributaries support chinook, coho, chum and steelhead; the Cedar River and its tributaries are important spawning areas for all species, especially sockeye salmon. Beach spawning has been observed in Lakes Washington and Sammamish especially along shores where bottom conditions and water quality are most suitable (RIBCO, Water Quality, 1974; McGreevy, 1973). It appears that combined sewer overflows at 14 points empty directly onto chinook and sockeye salmon spawning grounds in Lake Washington (Table 2-8). These two salmon species spawn in September, October, November about the time fall rains and combined sewer overflows begin. The transitional zones such as the Ship Canal and the brackish lower Duwamish estuary are necessary to the downstream migrants' physiological adjustment to saltwater. The quality of these waters is crucial as juvenile fishes are extremely sensitive to environmental parameters.

The State of Washington operates chinook and coho salmon hatcheries on Issaquah Creek in the Lake Washington drainage basin and on Big Soos Creek near Auburn in the Green River drainage basin.

Factors that limit fish production include low river flows, with accompanying increases in water temperature and decreases in dissolved oxygen because of municipal and industrial diversion; contaminants from urban runoff; and physical obstacles to anadromous fish passage such as diversion dams.

Salmon are fished commercially by gill net in the study area alongshore and into deep waters mid-channel from Alki Point south to Lincoln Park. Salmon are purse seined from Carkeek north alongshore. Sport fishing for salmon is concentrated off the Ship Canal (Shilshole Bay) and north and south of West Point, but also occurs south of Carkeek, across the mouth of the Duwamish (Harbor Island) and in Elliott Bay. Commercial herring fisheries are along northern Alki shores. Commercial bottom fish are taken in an area north of West Point to mid-channel.

Non-salmon sport fishing is also important. One steelhead line runs up the Ship Canal and another up the Duwamish. Sport bottom fish are taken just north of Shilshole Bay along the coast (Washington Marine Atlas, 1972). The runs of Pacific salmon and migratory trout in the Lake Washington basin


Puget Sound
SNOHOMISH COUNTY
KING COUNTY
LAKE WASHINGTON
LAKE SAMMAMISH
MIGRATION PATHS
CRITICAL MIGRATION AREAS
● CHINOOK SALMON SPAWNING SITES
○ SOCKEYE SALMON SPAWNING SITES

Salmon Spawning Sites
FIGURE 2-18

Source: McGreevy, R., Seattle Shoreline Environment, City of Seattle, 1973

TABLE 2-8

COMBINED SEWER OVERFLOWS EMPTYING NEAR SALMON SPAWNING SITES IN LAKE WASHINGTON

Overflow	Fish Potentially Impacted
013	Sockeye
014	Chinook
015	Chinook
W011	Chinook
024	Chinook
025	Chinook
040	Chinook
041	Chinook
042	Chinook
043	Chinook
165	Chinook
046	Chinook

Source: McGreevy, 1973; Metropolitan Engineers, 1976 are reportedly increasing each year (RIBCO, 1974).

The Duwamish Estuary

The biology of the Duwamish estuary has been described for the various trophic levels for the years 1973 and 1974 ("base line") conditions and historically (pre-1973) by STR (1975). The physical and chemical characteristics of the estuary are described in the same report and in Metropolitan Engineers Facility Planning Task Reports (1976).

The producers in the Duwamish are aquatic plants of which marine and freshwater phytoplankton and plants of the attached community are characterized by their sensitivity and growth response to environmental conditions. Blooms are not nutrient limited in the Duwamish, but are the combined result of appropriate physical factors,conditions characteristic of summer.

Nutrients in Renton secondary effluent are believed to increase productivity levels in freshwaters in the Duwamish (Welch, 1969; Farris, personal communication, 1977). Attached microfloral growth rates are also generally correlated with nutrient levels. Plankton blooms occur primarily in the lower estuary, where nutrients brought in by the saltwaters mask any effect of Renton effluent.

Dependent upon these tiny plants are zooplankton, benthic macroinvertebrates and vertebrates, demersal and pelagic. Zooplankton species lists for the Duwamish estuary are available (Harmon *et al*., 1974).

Benthic macroinvertebrates of the Duwamish are clams, polychaete worms and a variety of crustaceans--ostracods, amphipods, isopods, euphausids and others. Worms, which are most abundant, plus some crustaceans form the diet of most bottom-dwelling fishes.

Demersal migratory and resident fishes species composition (30 species) and abundance have been established (Matsuda *et al*.,1968). The most abundant species are the shiner perch, Pacific staghorn sculpin, and starry flounder. Chinook salmon is the major migratory species of which most individuals in the Duwamish are fingerlings from the Soos Creek hatchery. The estuary is a spawning and rearing area for these and many other species. Indeed, the majority of the individuals present in spring and summer are juveniles. Other dominant species are English sole, Pacific snake blenny, and the padded sculpin. The total number of species varies little through the year, unlike relative abundance of individuals of a species.

Demersal fish abundance can be limited in the Duwamish by low dissolved oxygen concentrations and high summer water temperatures. Low DO can affect salmon by delaying migration, causing mortalities or generally weakening the fish. Dissolved oxygen levels of less than 4.5 mg/l have been found to cause fatigue, and most bottom fishes will leave an area where DO is less than 2 mg/l. DO standards of 5 mg/l in saltwater and 6.5 mg/l in freshwater are violated during low flow periods (summer and fall) in the lower river. Minimum DO concentrations in 1975 were 1 mg/l below standards, or 4 mg/l (saltwater and 5.5 mg/l (freshwater).

Chinook salmon migrations upstream have become progressively earlier over the last 22 years, probably due to hatchery egg-taking practices. Adult salmonids recognize and can avoid the low DO concentrations common in the estuary's saltwater layer in late August and early September by migrating upstream in the freshwater layer. Sensitive downstream migrants, which spend June and July in the estuary, are apparently also somewhat able to detect and avoid water quality problems.

Raw sewage was diverted from the Duwamish in 1969, generally relieving late summer DO problems; however, projected increases from Renton sewage treatment plant may mean a return of the situation as secondary effluent has DO of 2 mg/l and the conversion of increased ammonia loads to nitrates will consume oxygen (RIBCO, 1974; Metro staff, personal communication, 1977) if secondary treatment continues without upgrading.

Fin erosion and liver abnormalities are characteristic of Duwamish starry flounder of 6 - 10 inches length. From 2.6 to 66.6 percent of fish samples were affected. Microbiological studies were inconclusive but Duwamish fishes had significantly higher levels of skin bacteria than fishes in the sewage areas. Several types of evidence suggest that skin erosion and liver disease in the Duwamish are different expressions of a single systemic disease caused by the action of one or more toxic chemical contaminants, possibly PCB's, followed by bacterial or viral infestation. Studies on 22 species of fishes of New York and Southern California associate this disease with sewage outfalls.

Fin erosion was induced in English sole by maintaining them in aquaria containing Duwamish River sediment, but not in fish on Nisqually River sediment (control). Bacteria associated with fin erosion are most commonly of the pseudomonad and enterobacterial groups (NOAA, 1976; McCain et al., in press; Wellings et al., 1976).

Freshwater Environments

The freshwater lakes and streams in the study area provide an important habitat for aquatic plants and animals and have recreational, commercial and industrial uses. Migratory fish populations central to the area's sport and commercial fishing depend on this habitat for spawning and rearing. Salmon are sensitive to environmental conditions and are often used as indicators of water quality.

Lake Washington

Physical and chemical characteristics of Lake Washington have been studied extensively, and briefly presented in previous sections of this report. The aquatic plant community is composed of phytoplankton, attached microflora, and macrophytes. The increase in blue-green algae from 7% to 96% from 1950 to 1962 (summers) has been partially reversed by the diversion of sewage by Metro. The 1950 condition has not been recovered but undesirable blue-greens are being replaced by green algae and diatoms. Productivity in Lake Washington has been thoroughly studied (Edmondson, 1972).

Zooplankton feed on algae and are in turn food for fishes. The benthic macroinvertebrates, which are also eaten by fishes, are oligochaete worms, leeches, clams, insect larvae (chironomids), amphipods and crayfish. The most abundant of resident fishes are yellow perch, peamouth, northern squawfish, largemouth bass, black crappie, large-scale suckers, brown bullhead, and prickly sculpin. Also common are longfin smelt, carp, and threespine stickleback. Migratory species moving through the lake to spawning grounds in the Cedar River are chinook, coho, sockeye and chum salmon, steelhead, cutthroat and dolly varden trout. Some chinook and sockeye salmon spawn in the lake; sockeye use it as a rearing ground as well for a year or more. Species lists are given in STR Report Vol. II Supplement (1975).

Lake Sammamish

To the east of Lake Washington in a suburban area is Lake Sammamish. More productive than Lake Washington (classed mesoeutrophic), it nevertheless is somewhat similar in species composition. Unlike Lake Washington, however, its deeper portions (greater than 63 ft depth) are devoid of oxygen in summer, limiting available habitat. Issaquah Creek, on which the state maintains a salmon hatchery, drains into the lake and supports coho, chinook, and sockeye salmon runs. The quality of Lake Sammamish has not changed substantially, but in 1970-74, blue-green algae decreased an average of 40% over 1964 to 1965 levels. A survey of the benthos has indicated that chironomid larvae are the most abundant forms in sublittoral and deep areas, reflecting a condition in keeping with high productivity and low dissolved oxygen conditions. A review of Lake Sammamish water quality and biological indicators is given in Metropolitan Engineers Task D3 (1976).

Green Lake

Green Lake, bordered by fill, major sanitary landfill sites and two combined sewer overflow points, lies completely within a developed residential area. It is eutrophic and has a muck bottom 10 to 20 feet thick. The lake is subject to algae blooms, thought to be primarily the result of subsurface seepage. The fish are primarily stocked rainbow trout. The Game Department periodically poisons to remove undesirable fish species before restocking with trout (McGreevy, 1973). Green Lake is also an important waterfowl resting area. The waterfowl droppings, runoff, and, perhaps to a small extent, combined sewer overflows undoubtedly contribute to the overenrichment of nutrients in this lake.

Lake Union/Ship Canal

The Lake Washington Ship Canal connects Lake Washington through Lake Union to Shilshole Bay. The University of Washington maintains a salmon and steelhead hatchery at Portage Bay. Lake Union has been changed significantly by industrialization of its shores and saltwater intrusion from the Hiram Chittenden Locks. Some deep bottom sediments are totally devoid of fauna, and the physical/chemical water quality data suggest that Lake Union waters are generally unfavorable to salmonids. Resident fish are similar to those found in Lake Washington, such as yellow perch, peamouth, northern squawfish, largemouth bass, black crappie, and brown bullheads, which generally have less stringent environmental requirements than salmonids (Metropolitan Engineers Task D3, 1976).

The Ship Canal was last dredged in 1954 by the U.S. Army Corps of Engineers for navigational purposes. Perhaps the most important biological use of the Ship Canal is for migratory fish passage to spawning and rearing grounds in the Lake Washington drainage. Hatchery production and escapement records show that this migratory route supports valuable sockeye, coho, and chinook runs. A fish ladder has been installed at the locks which allows the passage of migratory trout and salmon. This run constitutes a significant part of the salmon migration in eastern Puget Sound.

Lake Union, which exceeds dissolved oxygen and coliform standards, is considered to be mesoeutrophic. Nutrient sources are runoff, sewer overflows, atmospheric emissions and rainfall, and bacterial nitrification. Even in its somewhat stressed condition, Lake Union and the Ship Canal comprise an important waterfowl area. There is also evidence of migrating salmon appearing at the south end of the lake, either from confusion or avoidance of unfavorable conditions (Metro Baseline Study Draft, 1976, quoted in Metropolitan Engineers Task D3, 1976)

Existing Environmental Conditions

Sammamish River

In 1964, the Sammamish River, which connects Lake Sammamish with Lake Washington, was completely channelized for flood control by the U.S. Army Corps of Engineers. The river has suffered from the rechannelization and from urbanization, low flows and high temperatures, which are removing salmon spawning and rearing habitats and creating conditions unfavorable even for fish passage. Furthermore, pollutants entering the river may affect the quality of Lake Washington downstream. Water quality and biologic conditions and standards violations are discussed in Metropolitan Engineers Task Reports (1976).

Cedar River

The Cedar River drains into the southern end of Lake Washington and is considered to be of generally good quality in spite of temperature and dissolved oxygen problems in summer, year round violations of total coliform standards, and nitrates violations in winter.

Benthic productivity is felt to be higher than in most northwest coastal rivers. Mayfly larvae, considered to be "indicators" of good water quality (Mackenthun, 1969), were found in 1975 at sampled sites on the lower Cedar River (Malick, 1975 in Metropolitan Engineers Task D3). Diversity was not significantly different between the upper and lower reaches of the river sampled. The Cedar River, as discussed previously, is an important salmon spawning area, which may be threatened by summer low flow conditions. It has been suggested (Stober and Graybill, 1974) that a minimum flow of 240 cfs be maintained to ensure spawning conditions.

Other Waters

In this group are small lakes and ponds and small streams. Small lakes are generally interspersed among forest, agriculture, rural/suburban and urban areas. Most are eutrophic or mesotrophic, as outlined in Metro's monitoring program, and have less strictly aquatic life and more water-associated terrestrial organisms, such as waterfowl, raccoons, beaver, muskrat, and insects. Small streams are abundant inside as well as outside the study area and provide habitat for fish and wildlife. Existing and future blockages and excessive sediment deposition will eliminate these as will contaminants and runoff, which are presently damaging benthic communities. Certain of the descriptions of surface waters in this document are brief, as the waters are not expected to be directly impacted by the facilities planned. Secondary or indirect impacts of future growth are expected, but not well defined, as discussed in Chapter III of this report.

Rare or Endangered Species and Sensitive Habitats

Environmentally sensitive areas have been defined in Metro Resolution No. 2582 (Section 5) to include "a. Shorelines of the state, b. Other areas including those with unstable soils, steep slopes, unusual or unique flora or fauna or areas which lie in flood plains which the Executive Director may hereafter designate as environmentally sensitive areas." This portion of the biotic section treats shorelines and "unique or unusual flora and fauna".

Endangered species are included in this category. Only four subspecies found in Washington are on the endangered list of the U.S. Bureau of Sport Fisheries and Wildlife: the American peregrine falcon, the Arctic peregrine falcon, the Aleutian Canada goose and the Columbia white-tailed deer. None of these are recorded from the study area.

A more extensive but preliminary list, which also includes rare and threatened reptiles, birds and mammals in the Green River sewage area, is given in Appendix Table D-10 (Metropolitan Engineers Task A5, A1G,B5F Appendix, 1976). Of these, water-associated birds and reptiles would be most affected by the facilities planned. Sensitive areas other than such habitats are salmon spawning and rearing areas, fish migration routes and waterfowl resting areas.

Sockeye salmon spawn in a few restricted nearshore areas in Lake Washington (Figure 2-18). Such areas, which occur off Pleasure Point, Seward Park, Enatai Beach, Beaux Arts, North Mercer Island and Juanita Beach, are quite vulnerable to sedimentation, dissolved oxygen depletion and temperature changes (Metropolitan Engineers, 1976). The lower Duwamish River, Elliott Bay, Lake Union, Salmon Bay, and Shilshole Bay serve as critical transition zones where homeward migrating adult fish and outward migrating juvenile fish acclimate to changing salinity (McGreevy, 1973). During migration to and from saltwater, fish undergo natural physiological stress. Any additional physical insult adds to this stress and results in mortality directly, or indirectly from increased disease susceptibility associated with increases in temperature and toxicant concentrations. Removal or replacement of natural shoreline areas destroys feeding and protective areas for juveniles enroute to Puget Sound. When forced into open waters, they are more vulnerable to predation. As mentioned, there is evidence that in Lake Union migrating salmon are appearing in the south end of the lake, an abnormal event. Recommended temperatures and dissolved oxygen levels for fishes are given in Appendix Tables D-11 and D-12.

Waterfowl and water-associated birdlife occur throughout the study area. The Seattle area is principally a wintering and resting ground for birds using the Pacific flyway during the fall migration south and again for the spring migration north. Most species of waterfowl utilize either saltwater areas of Puget Sound or the freshwater area of the Duwamish, Lake Washington and the Ship Canal. In addition, the study area has a considerable population of resident waterfowl on marine shoreline and freshwater marshes, usually in inlets or coves where human activity and pollution is minimal (McGreevy, 1973). "Significant" marine birds are found at the Carkeek Park area, at Richmond Beach, West Point, Alki, Salt Water Park, the Duwamish-Harbor Island area, Shilshole Bay and especially at Elliott Bay (Salo, 1975). Waterfowl feed on a variety of marine and freshwater plants and animals including dying salmon and salmon eggs and thus these birds would be adversely affected by the same actions that impact salmon spawning, rearing and migration areas, but to a lesser extent. If some conditions are degraded, the birds will leave the area. More insidious are increased levels of pollutants such as pesticides, which may enter the food chain undetected by the individual animal but which can cause general reproductive failure or other severe physical effects.

The most sensitive aquatic habitats are considered to be those with minimal mixing and dilution capacity and unique flora and fauna (Metropolitan Engineers, 1976) such as sockeye salmon spawning and rearing areas, and lake shallows. Waters considered to be in this group are Green Lake, the Green River, the Duwamish River, the Sammamish River, Lake Union/Ship Canal, Lake Sammamish, Lake Washington shorelines, and sections of the Puget Sound intertidal (eelgrass beds, clamming beaches).

Moderately sensitive habitats have limited mixing and dilution. Examples are Elliott Bay, marshlands, fish migration routes, other portions of the Puget Sound intertidal, certain Puget Sound nearshore areas, and Lake Washington offshore areas.

Less sensitive areas are narrow littoral zones in lakes and marine offshore waters characterized by good mixing and dilution. These classifications are based on the writer's judgement and the sensitivity analysis of Metropolitan Engineers Task Report A5, AlG, B5F (1976). The habitats of small lakes and streams are not included in this classification with the exception of those containing salmon spawning areas, as these waters presently lie outside the area of primary impact from the proposed project. Future secondary impacts may be substantial but are not defined well enough to classify as to sensitivity.

NATURAL RESOURCES AND ENERGY

The major natural resources required by each of the eight Alternatives A-H in the Metro 201 Plan include wastewater treatment chemicals and construction materials. Energy production for facilities operation would require natural gas, hydroelectric power and/or other sources of energy. The current status of these resources as related to Metro facilities is summarized below. Additional information can be found in the following publications: "Soil, Air, Population Growth and Resource Constraints", Tasks B5A, B5B, B5D, B5E (Draft), (Metropolitan Engineers, October 1976) and Final Regional Analysis Report, (Human Resources Planning Institute in conjunction with Howard Edde, Inc. October 1976).

Chemicals and Materials

The chemicals that may be used in the wastewater treatment facilities include chlorine, sulfur dioxide, lime, ferric chloride, various polymers, sulfuric acid, alum, and activated carbon. Chlorine (Cl_2) is used for disinfection of bacteria and viruses. Sulfur dioxide could be used as a dechlorination agent since chlorine reacts with organic residuals to form such substances as chloramines and chlorinated hydrocarbons, which may be toxic to organisms. Lime (CaO), ferric chloride ($FeCl_3$), Alum ($Al_2(SO_4)_3$), and polymers would be used in physical/chemical processes as coagulant aids in solids removal processes such as enhanced primary treatment. For advanced waste treatment, methanol (CH_3OH) would be used for denitrification; salt or sodium chloride ($NaCl$) for recharging ion exchange beds; and activated carbon for adsorption of organics.

The reliability of future supply for wastewater treatment chemicals varies from moderate to high and most are produced in the Pacific Northwest (HRPI, 1976). Lime and ferric chloride are in "moderate" supply; supplies of the other chemicals are highly reliable. The closest supply for ferric chloride would be Antioch, California and the supply of activated carbon would probably be Marshall, Texas.

Specific requirements for various wastewater treatment chemicals will be discussed in the section of this report on alternatives and impacts.

The materials that would be used in construction of Metro wastewater treatment facilities are cement, sand and gravel, steel, structural metal, wood products, plastics and metals for various pipes, valves and fittings. The reliability of supply for all of these construction materials is high for the Puget Sound region (U.S. Department of Commerce, 1976).

Energy

Energy for wastewater treatment is used on site for operation and maintenance, as supplied by purchased electricity. On-site energy is also needed for anaerobic digestion. To keep the anaerobic digestion process at its maximum rate, the sludge being digested is heated to 90°-95°F, which requires energy. However, anaerobic digestion also produces methane gas which can be used as an energy source. Generally, in the Seattle area, anaerobic digestion of sludge produces two to three times as much energy as it consumes. Offsite energy is needed to produce treatment chemicals and to truck sludge.

Types of energy used include gasoline, diesel oil, electricity, methane, and natural gas. The suppliers of these types of energy for the Metro service area include Seattle City Light, various oil companies, the Bonneville Power Administration, the Northwest Pipeline Corporation and, for the production of methane, the anaerobic digester component of the wastewater treatment process. With the exception of natural gas the reliability of all of these energy forms in the Seattle Metro service area is high. The reliability of natural gas is rated low. (Hepple, 1972; U.S. Department of Commerce, PB-245-422; FEA, 1976, Edison Elec. Inst., 57th; Liquid Carbonic Corp., CO_2).

Total energy consumption for all Metro wastewater facilities would be in the range of 50 to 170 million kwh/year for alternatives A through H. An equivalent amount of energy would be consumed by 2,500 to 8,500 houses in the northwest area (where one house is estimated to consume an average of 20,000 kwh/year).

Fisheries

Fresh water anadromous and marine fish in the Puget Sound area are both commercial and recreational resources of major importance (see Table 2-9). These fisheries are more fully described in other sections of this report. The commercial value of these fish is illustrated by Figure 2-19. The fishing industry associated with the Puget Sound area is a very important national resource, not only for the fishery and catch, but also for the processing of much of the U.S. Northwest fishery resource.

THE HUMAN ENVIRONMENT

Various factors determine what is generally described as the human environment. For the purpose of this Environmental Impact Statement the human environment related to the Metro service area is defined by the following basic variables:

- Land use and land use planning
- Existing and projected population
- Economic and financial considerations
- Social, recreational and cultural features
- Archeological and historical resources
- Health and safety considerations
- Legal and institutional constraints
- Aesthetic and nuisance features

This section of the EIS briefly describes human environment conditions in the Metro service area.

Land Use and Land Use Planning

Approximately 75,000 acres make up the municipal watershed for the City of Seattle. Much of the land within the Metro service area falls into one of the classes of urbanization (residential, commercial or industrial). While some agricultural land exists, the bulk of the undeveloped land is forested. Figure 2-20 presents the existing land use conditions for the Metro service area and Table 2-10 presents existing land use for King County and Snohomish County (Metropolitan Engineers, 1976; RIBCO, 1974).

Various plans, guidelines and state and local regulations pertaining to the use of land within the Metro service area are pertinent to the wastewater facilities plan. These include the State Shorelines Management Act, the Seattle Shorelines Master Plan, the Comprehensive Plan for

TABLE 2-9

SELECTED CHARACTERISTICS OF PUGET SOUND FISHERIES[1]

Fish	Type of Benefit		Major Shoreline Linkages in Puget Sound		
	Commercial	Recreational	River Delta Areas	Other Shoreline Areas	Unknown
Salmon	X	X	X		
Steelhead		X	X		
Shellfish					
Clams	X	X		X	
Oysters	X	X		X	
Crabs	X	X		X	
Bottom Fish					
Rockfish	X	X			
Cod	X	X		–[2]	X
Flounder and sole	X	X			X
Other Food Fish					
Herring	X	–[3]		X	

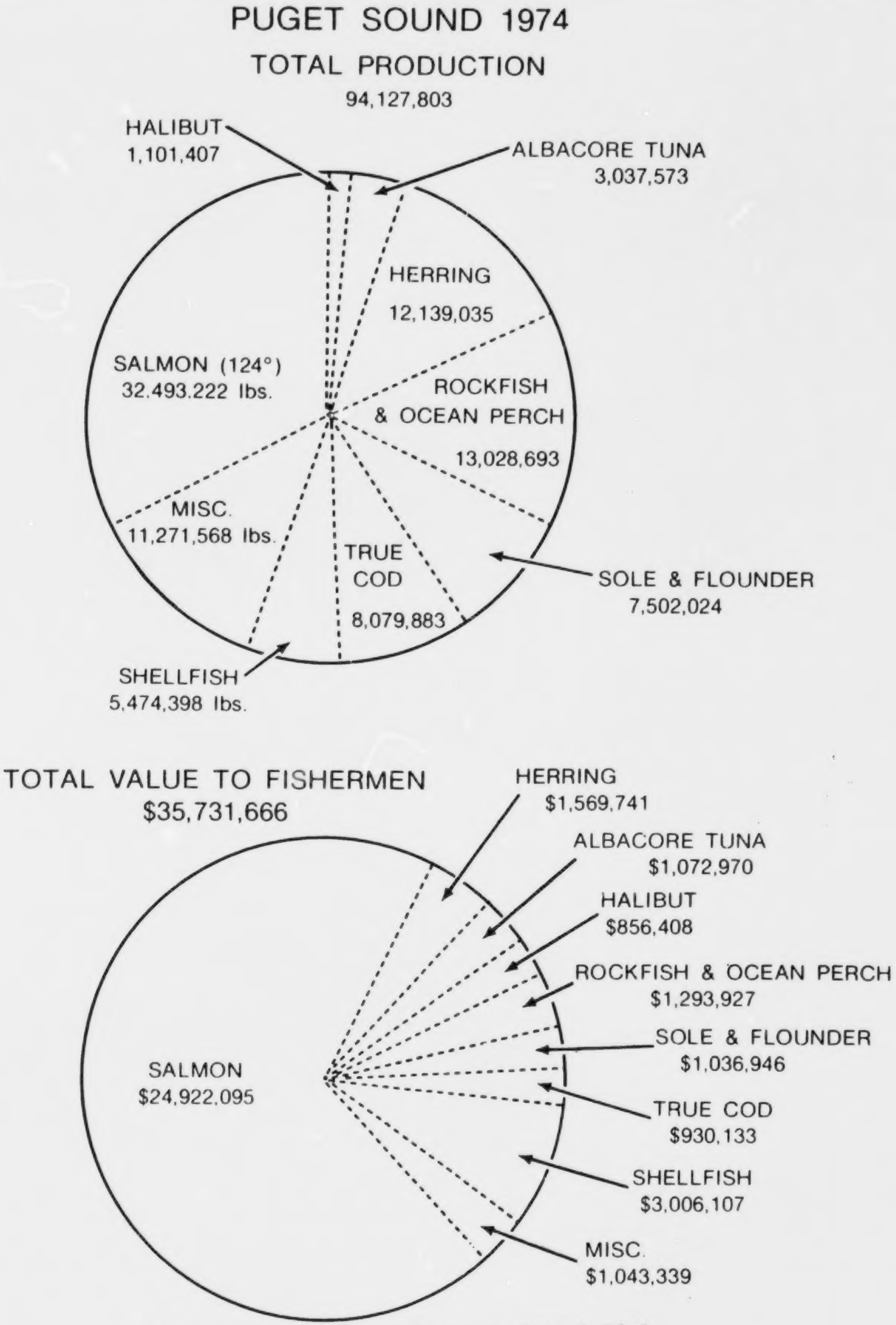
---

[1] Includes Puget Sound and adjacent estuarine areas.

[2] The lingcod appears to have significant shoreline linkages in Puget Sound.

[3] Herring are used as baitfish for sport fishing.

(Fisheries Statistical Report, 1974)



Commercial Value of Puget Sound Fish

FIGURE 2-19

Source: Fisheries Statistical Report 1974

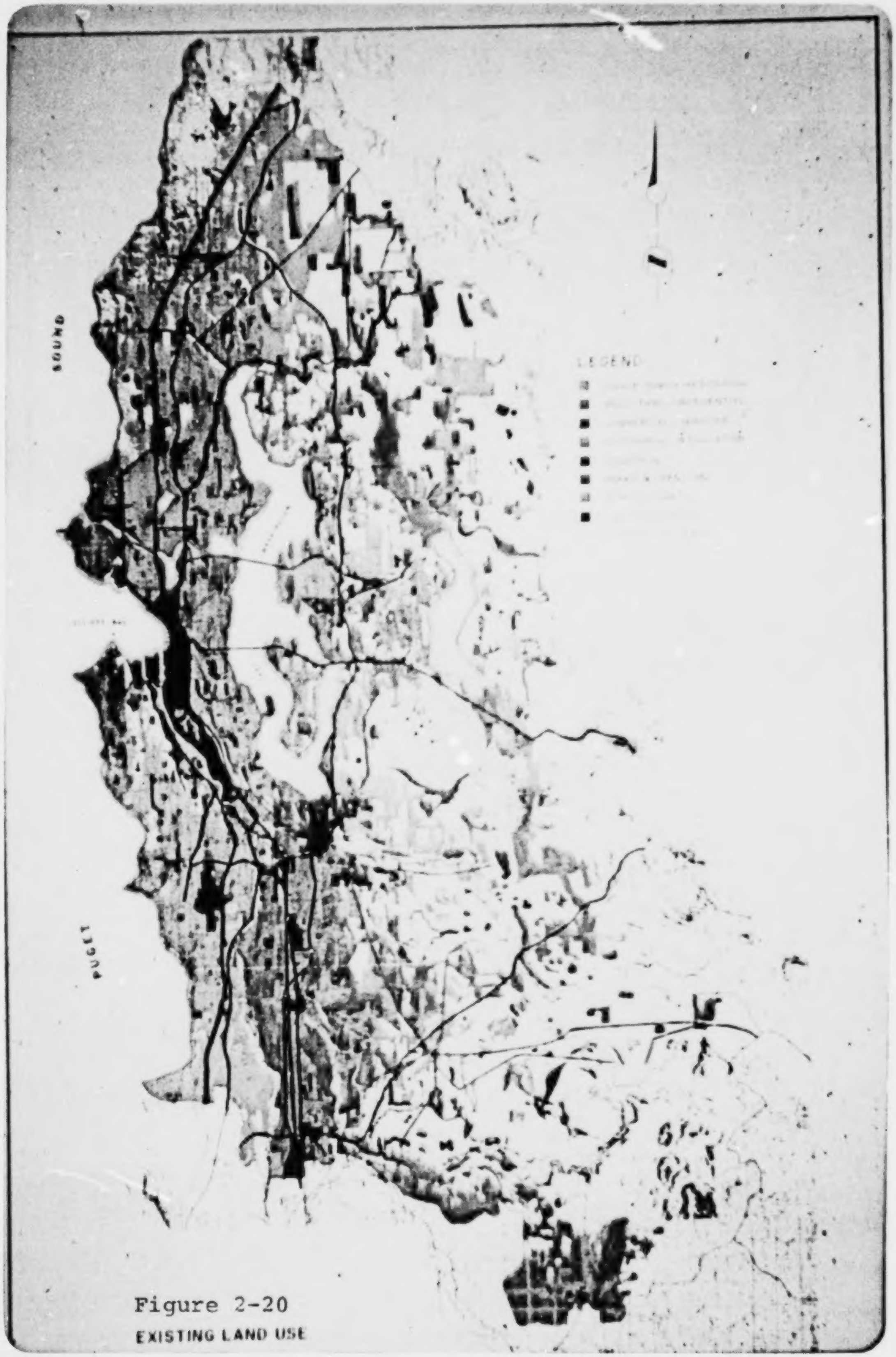

SOUND
PUGET
LEGEND

Figure 2-20

EXISTING LAND USE

TABLE 2-10

EXISTING LAND USE 1970
(acres)

	King County	Snohomish County
Single and multi-family	58,200	14,399
Retail and trade	2,003	553
Finance, insurance, real estate; personal, professional and repair services	3,039	675
Manufacturing	2,866	1,364
Wholesale, transportation, communication, utilities	2,804	501
Government and education	5,730	1,618
Parks and designated open space	6,305	991
Streets	38,603	10,177
Agriculture, vacant open space, and vacant construction	221,943	115,317
15% slope and/or subject to flood	92,888	30,641

King County, the King County Shorelines Plan, King County Code Titles 20 and 21 (Zoning and Land Use Codes), the King County Building Code, the State Flood Zone Act, the King County Filling and Grading Ordinance, Building Regulations for the City of Seattle, the Seattle Land Use and Zoning Codes, and the King County Shoreline and Management Plan.

The general provisions applicable to the Metro Facility Plan of these various local land use controls are as follows.

City of Seattle

As part of its general review authority, the City of Seattle would review the construction of a sewage treatment plant, rehabilitation of sewer lines or extension of sewage facilities through its Building Department. Two permits are required from the Seattle Building Department for the construction of facilities, including one which examines general design and construction and a second concerning filling and grading activities. The Seattle Shorelines Management Plan implements the Washington State Shorelines Management Act (RCW 90.58). This document controls development within 200 ft of the significant shorelines in the city, including rivers and streams with flows greater than 5 cfs, lakes greater than 20 acres and all marine waters.

King County

In 1964 King County adopted a comprehensive plan. Certain provisions of this plan relate to the Metro Facility Plan and are included as follows:

> "Utilities Development Policies
>
> Trunk utility lines should be installed in advance or at the time of development in accordance with the general plan for the area. Local or service utility lines should be installed as needed.
>
> Where pollution conditions now exist, all possible steps should be taken to correct such conditions."

Any development activities occurring in a state designated flood zone within King County would require a permit for construction from the county. In addition, King County Ordinance 2281 specifies that the Public Works Department review and approve construction activities which modify the drainage of 5,000 sq ft of land surface, with particular attention to any increases in storm runoff that might occur. Filling and grading activities in excess of 5 ft must have a filling and grading permit. The King County Shorelines Management Plan implements the State Shorelines Management Act and applies to portions of the Metro service area.

Puget Sound Council of Governments

The regional comprehensive planning agency for the central Puget Sound region is the Puget Sound Council of Governments (PSCOG). Its membership includes Bremerton, Everett, Seattle, Tacoma, Kitsap County, Snohomish County, Pierce County and King County. Its primary purposes are to develop a regional planning program and a regional comprehensive plan, and to formulate recommendations to member counties, cities and other jurisdictions. Also, PSCOG is the A-95 Review Agency (Federal Clearinghouse) and as such is charged with review and comment on all federal-related projects within the PSCOG area. The PSCOG through its predecessor, the Puget Sound Governmental Conference, has adopted an Interim Regional Development Plan. However, it is now considering for adoption, "Goals and Policies for Regional Development" (December 1976) which would supercede the Interim Plan. Related to public services and utilities, such as the Metro Facility Plan, the following goal is included in the goals and policies under consideration. A similar goal exists in the Interim Regional Development Plan now in effect (PSCOG, 1976).

> "Goal
>
> It is in the public interest to minimize the costs of future growth by encouraging new development within urbanized areas where necessary investments in public services have already been made."

In further expanding on this goal the following policies are included in the proposed document.

"1. Existing public utilities, facilities and services shall be used to their fullest prior to expansion.

3. Encourage conservation efforts and the maximum utilization of utilities and services before increasing supply.

4. Land for new urbanization should be staged through a series of growth management decisions including public service extensions.

5. The pattern of development which produces the least cost in new public utilities, facilities and services shall be encouraged within feasible limits.

6. Encourage consideration of adopted estimates of growth, availability of space on regional basis, and fiscal impacts on the region and jurisdiction prior to providing public services to new area.

7. Plans for public services shall be consistent with regional growth policies and local comprehensive plans and shall be based upon: 1) criteria for population and employment distribution; 2) policies designed to limit demand, 3) responsible fiscal management."

Another goal of the PSCOG document related to natural environment and amenities is the following.

> "It is in the public interest to maintain the natural beauty and liveability of the region through sensitive treatment of nature in development."

Pertinent policies following from this goal are:

"1. The natural beauty and liveability of this region shall be a primary consideration in the location, timing and quantity of growth.

    a. Natural amenities identified as important to the region's character and beauty shall be preserved or sensitively developed as a second choice.

b. Patterns of development which
minimize adverse impacts on these
amenities shall be encouraged.

5. Encourage efforts to develop nonstructural solutions to environmental problems.

17. Permanent structures designed for human habitation, commerce, employment or public assembly should not be located within high risk zones, including 100 yr floodways, earthquake zones, or active landslide zones.

25. Achievement or maintenance of ambient air quality standards and surface and groundwater quality standards as established by law is recognized and supported."

Population

The population of the entire Puget Sound Region went from approximately 1,000,000 in 1940 to approximately 2,000,000 in 1976. Two rapid growth periods occurred, first during World War II, and then during the early 60's because of a resurgence in commercial air transport construction. During the 50's, late 60's and early 70's the growth rate dropped, particularly in the early 1970's due to cut-backs in the aerospace industry.

The current and projected populations within the Metro study area have been used as the basis of facilities planning. The service area populations were estimated by Metro and Metropolitan Engineers, based on Puget Sound Council of Government's projections. The PSCOG forecast populations in activity allocation model (AAM) districts based on an independent economic base study, allocated to AAM districts according to policies and 1960 - 1970 patterns by multiple regression. The PSCOG forecasts for 1980, 1990 and 2000 were interpolated for 1985 and 1995 projections and extrapolated to 2005 by Metro. Individual AAM populations were then divided as necessary and apportioned into existing service area boundaries. Estimates of sewered and unsewered populations were developed as described in the Draft Facility Plan. The resulting 1975, 1985 and 2005 populations by present service area are shown in Table 2-11.

The total Metro service area population for 2005 was forecast at 1,502,000 for the Draft Facility Plan. In service areas currently designated for the West Point, Alki, Carkeek Park and Richmond Beach plants, the estimated popu-

TABLE 2-11

METRO 201 STUDY AREA POPULATION PROJECTIONS

	1980		1990		2000		2005	
Service Area	Sewered	Total	Sewered	Total	Sewered	Total	Sewered	Total
Alki	42,400	42,400	46,500	46,500	43,200	43,200	43,200	43,200
Carkeek Park	25,600	25,900	27,000	27,300	27,700	27,800	28,100	28,100
Richmond Beach	16,900	17,000	21,700	27,900	27,900	28,900	32,000	32,000
North Lake Washington	43,100	88,500	90,500	126,500	148,400	157,500	166,500	173,500
North Lake Sammamish	32,000	53,000	49,200	75,000	67,000	94,000	75,000	102,000
West Point*	491,500	497,800	519,000	535,000	524,500	540,500	527,300	543,000
Renton**	276,500	406,000	435,000	558,300	612,000	698,300	700,000	770,000
Total	928,000	1,130,600	1,188,900	1,396,500	1,450,700	1,590,200	1,572,100	1,691,300

* Includes the proposed Val Vue connection change but excludes the North Lake Washington and North Lake Sammamish sewer service areas.

** Includes the proposed Val Vue connection change but excludes the North Lake Sammamish sewer service area.

lation would be 943,000 by 2005. These populations and distributions thereof were maintained consistently for all alternatives in the Draft Facility Plan. However, with various alternatives for wastewater treatment plants and intended sewerage service, the population tributary to a given treatment plant would vary depending on the choice of alternative, plant sizing, location, and collection system. A summary of population (sewered and total) by future service area for the year 2005 is shown in Table 2-12.

Economic and Financial

Seattle is a major economic center for the Northwest. Employment projections are shown in Table 2-13. Water oriented outdoor recreation and commercial fishing and its related industries are major components of the economy. A brief discussion of the commercial value of the fisheries is presented in the section of this report on natural resources and energy. Further information is in Metropolitan Engineers Task A1 and B2 reports (1976).

Recent trends in wages reflect economic conditions in the greater Seattle area (HRPI Regional Analysis, 1976). In 1970-71 the aerospace industry terminated approximately 50,000 people. Since then manufacturing employment has remained relatively constant, and moderate growth has occurred in most nonmanufacturing industries.

Total manufacturing wages grew at an average rate of 1.14% annually during the period from 1964 to 1974, but fell slightly from 1970 to 1974. The nonmanufacturing industries in the SMSA have relatively lower average wages than the manufacturing industries, but showed steady growth from 1964 to 1974.

The highest average wage and highest average annual increase in nonmanufacturing was in transportation, communications and utilities, averaging a 1.81% increase. The greatest growth in average wages was in lumber and wood products averaging 2.8% annually over the 10 year period from 1964 to 1974.

A major economic consideration relates to the possible development of a new wastewater treatment site in the Interbay area. The Commodore Way site in Interbay is an option but not the site evaluated for costs and other feasibility, in Alternative G. This site currently is developed by 60

Table 2-12

Service Area Population Projections

Service Area	1975		1985		2005	
	Sewered	Total	Sewered	Total	Sewered	Total
Alki	44,000	45,000	45,000	45,000	54,000	54,000
Carkeek Park	23,000	25,000	23,000	25,000	30,000	31,000
Richmond Beach	17,000	20,000	19,000	22,000	26,000	27,000
West Point	510,000	609,000	600,000	660,000	785,000	831,000
Subtotal (Primary Study Area)	594,000	699,000	687,000	752,000	895,000	943,000
Renton	218,000	335,000	300,000	400,000	280,000	559,000
Total (Total Metro Planning Area)	812,000	1,034,000	987,000	1,152,000	1,175,000	1,502,000

TABLE 2-13

EMPLOYMENT PROJECTIONS

		Projected Employment (thousands)										
		Retail*		F.I.RE/ Services*		Manufacturing*		Whsle/T.C.U.*.		Gov't Education*		
Year	County	Emp.	% Total	Emp.	% Total	Emp.	% Total	Emp.	% Total	Emp.	% Total	Total
1970	King	68.7	16.3	103.7	24.6	97.9	23.2	71.6	17.0	78.9	18.8	420.8
	Snohomish	9.3	14.8	9.4	14.9	28.9	45.9	4.9	7.8	10.5	16.7	63.0
	Pierce	18.5	19.7	23.8	25.3	19.5	20.8	11.0	11.7	21.1	22.5	93.9
	1970 total	96.5	16.7	136.9	23.7	146.3	25.3	87.5	15.1	110.5	19.1	577.7
1980	King	80.7	17.0	114.9	24.2	116.7	24.6	79.7	16.8	83.0	17.5	475.0
	Snohomish	13.2	19.2	11.5	16.8	24.1	35.1	6.9	10.1	12.9	18.8	68.6
	Pierce	23.9	21.7	26.6	24.1	22.6	20.5	14.1	12.8	23.1	20.9	110.3
	1980 total	117.8	18.0	153.0	23.4	163.4	25.0	100.7	15.4	119.0	18.2	653.9
1990	King	105.0	17.2	165.8	27.1	136.1	22.3	105.6	17.3	98.2	16.1	610.
	Snohomish	22.3	21.6	19.9	19.3	30.7	29.8	11.6	11.3	18.6	18.0	103.1
	Pierce	35.7	23.0	38.9	25.1	28.4	18.3	21.6	13.9	30.5	19.7	155.1
	1990 total	163.0	18.8	224.6	25.8	195.2	22.5	138.8	16.0	147.3	17.0	868.9

*See Table 5-1 for definitions.

industries, many of which depend on their placement at the Commodore Way site to establish their clientele with close-by seafood-related businesses. If the Commodore Way site was condemned for a sewage treatment facility, 700-800 jobs would be transferred. Many of these businesses may not be able to relocate. The cost of purchasing the land in this site has been estimated at $19.4 million (HRPI, 1976). More details on the Commodore Way site are mentioned in the regional document under Alternative G, which considers this site and in the West Point site document.

Costs

Costs for Metro wastewater facilities, whether existing or proposed, include three components: capital cost, operating and maintenance costs, and total annual costs.

The capital costs include the initial expenditures for construction of wastewater treatment plants, sewage collection systems, effluent disposal methods, combined sewer overflow control facilities, sludge handling and disposal techniques, plus the purchase of land and miscellaneous treatment-related equipment. These capital costs typically are major expenses that are made infrequently and that can be phased to suit planning requirements. Because capital or construction costs can require large sums of money at one time, they are often financed by bonds or other types of loans that are paid back, with interest, over a period of several years. The yearly payment on the original capital cost debt is referred to as the annual cost of capital or amortized cost.

Operation and maintenance costs include expenses such as wages for labor, purchase of chemicals and power, and replacement or repair of equipment. These costs occur continually or at frequent intervals during the life of the project.

The total annual cost of wastewater facilities is the sum of the annual payment on amortized capital and the annual operation and maintenance costs. The payment of total annual costs can be achieved by various means, including charges to persons who use the services.

The determination of costs for alternative wastewater facilities has been made for the Facility Plan (Metropolitan Engineers, 1977) and is summarized in this EIS. In determining the costs of each alternative, the following assumptions were made:

1. Capital costs were compared on a common basis of 1976 construction costs for the Seattle area (Engineering News Record Construction Cost Index of 2600 for costs in 1976).
2. Project capital costs were based on 2005 flows and loads.
3. Various financing possibilities were evaluated for capital costs and their effect on amortized costs and user charges.
4. Operation and maintenance quantities and costs were based on 1995 average flows and loads.
5. Annual cost of replacement parts were 0.5 percent of capital costs.
6. Metro would be responsible for 100 percent of operation and maintenance costs.
7. Total annual cost included annual cost of capital, computed at 6.125 percent for 20 years (20 equal payments of 8.8 percent of the original principal per year).

For more detail, the reader is referred to the Facility Plan.

In addition to the amount of the capital and the operation and maintenance costs, another important factor is the charge to users. Metro presently serves the equivalent of 425,000 sewered residential connections and charges $3.55 per month for each connection to defray the total annual costs of present wastewater facilities. (Individual sewerage service charges in the study area may vary since component agencies within Metro may add a monthly user charge of their own.) These Metro charges are the same for residential users regardless of customer location or volume of sewage.

Future user charges were computed for the various alternatives (Metropolitan Engineers, 1977), as discussed in Chapter III. Because the user charges are based on both amortized capital costs and operation and maintenance costs, the assumptions for capital cost financing influence projected user charges. Under the first assumption, all facilities described under alternatives until the year 2005 would be grant eligible; that is, EPA would continue to provide construction grants of 75 percent of the eligible capital costs as now practiced pursuant to PL 92-500. An additional grant of 15 percent from DOE is also part of the first assumption which continues the present grant funding conditions, leaving the remaining 10 percent of capital costs to be paid by Metro. Under the second assumption, future facilities would not be grant eligible after 1985, after which time Metro would pay 100 percent of construction costs. Prior to 1985, the eligible capital would continue at 75 percent EPA grant, 15 percent DOE grant and 10 percent Metro cost. Under the third assumption, no facilities presently being evaluated, would be grant eligible, and Metro would pay 100 percent of construction costs.

The discussion of future costs in Chapter III separates costs for the Puget Sound plants (or alternative sites) from the costs for Renton to the extent possible based on present agency policies and information from the Facility Plan (Metropolitan Engineers, 1977). Capital costs are identified separately for treatment plants, collection system and combined sewer overflow control methods that relate to the Puget Sound plants (or alternative sites) only, the Renton plant only, or the total. Similarly, annual operation and maintenance costs are separated in such a manner for comparing alternatives, However, the monthly user charges as currently developed in the Facility Plan include the costs for Renton (amortized capital, operation and maintenance) since the costs of all Metro facilities are distributed equally to all residential users (or equivalent). Also, future user charges under Alternatives B through H are based on 530,000 sewered residential equivalent connections.

A comparison can be made between the cost of Metro's wastewater treatment programs and the estimated cost of implementing PL 92-500 for the whole country. The national cost of PL 92-500 is shown in Table 2-14 (EPA, 1976).

Table 2-14

National Cost of Implementing PL 92-500

Needs Category	1990 EPA Assessment (Billions of Dollars)
I (Secondary Treatment)	12.955
II (More Stringent Treatment)	21.279
IIIA (Infiltration/Inflow)	3.017
IIIB (Replacement and/or Rehabilitation)	5.486
IVA (New Collector Sewers)	16.979
IVB (New Interceptor Sewers)	17.923
V (Combined Sewer Overflows)	18.262
Total I, II, IVB	52.158
Total I-V	95.902

Social, Recreational and Cultural

Social, recreational and cultural attitudes and values may be determined by an opinion poll or may be assumed to be reflected in the goals and policies adopted by the elected officials in the region. One such set of adopted directives for the Seattle area is entitled, Goals for Seattle, the report of the Seattle 2000 Commission which was prepared by citizens of Seattle and adopted by the Mayor and the City Council. The emphasis in this document, related to the Metro Facility Plan, is the protection and enhancement of natural and cultural conditions and the strengthening of existing communities. Sections related to water are quoted directly from the report as follows:

"D. Goal: Water

The City should undertake all means reasonable and feasible to ensure water purity to meet health standards and protect the environment.

1. Undertake efforts to meet Federal Water Pollution Control Act requirements by 1984.

   a. It is the national goal that the discharge of pollutants into the navigable waters be eliminated by 1985.

   b. It is the national goal that wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by July 1, 1983.

2. Participate actively in METRO and RIBCO (River Basin Coordinating Committee)

3. Encourage citizen-awareness of water pollution problems:

   a. Through higher cost and a revision of the rate structure, encouraging re-use of water.

   b. Encourage less water consumption.

   c. Regulate amounts used by industrial and residential consumers, by establishing usage priorities.

   d. Use fines and taxes to finance enforcement of current and future laws.

> e. Prohibit navigational wastes.
>
> 4. Regulate pollution of all water bodies, including creeks.
>
> 5. Encourage research on water pollution.
>
> a. Potential pollutants in storm water runoff.
>
> b. Usage of sewer sludge.
>
> 6. Ensure clean water to protect wildlife, vegetation and recreation areas. "

Another important statement within the Goals for Seattle report, concerns utilities and is excerpted as follows:

> "11. Utilities (the water, electric, sewer, storm drainage, and solid waste disposal projects) in Seattle, and those which will affect Seattle, shall be planned by the unit responsible for all the planning for the city, and shall be implemented and operated to achieve the goals of the people of Seattle.
>
> a. These public utilities should operate to carry out policy decisions made by the elected officials, not as private businesses for the promotion of private enterprise; utilities can provide the framework for the community patterns which have been chosen.
>
> b. The people of the city have been promoting the exodus of residents from the city by overpayment for utilities which are planned and operated by area agencies; Seattle should pay only its fair share for utilities."

In addition to the "Goals for Seattle" program, other public sponsored efforts have determined and/or set public goals and policies as follows: Shorelines Master Program, City of Seattle; Shorelines Management Master Program, King County; RIBCO; The Comprehensive Plan for King County 1964 - 1972; The Comprehensive Plan for the City of Seattle; Alternatives for Washington. The goals and policies expressed through these studies are presented in matrix form in Table 2-15. (HRPI, 1976).

Citizen Opinion Surveys

Citizen opinion surveys were conducted by HRPI, and

Gerhardt Research, in regions adjacent to the wastewater treatment facilities at Alki, Carkeek Park, Richmond Beach, and the Magnolia community near West Point.

When 377 randomly chosen citizens were asked, in a Gerhardt survey, what environmental concerns needed most attention, most responded that they could think of none. Those who did have an environmental concern mentioned such things as park upkeep, heavy traffic on streets, noise, or litter. Although a few mentioned water quality, none directly pointed out any of the wastewater treatment facilities as a most serious environmental problem.

Although most of the 377 interviewed knew of the treatment facilities (about 80-90%), they concerned few (5-30%). When asked if they would favor upgrading sewage treatment facilities as required by the law, the majority said "yes" (54-60%). Most who opposed were concerned about cost, necessity, or location of the facility. The highest number (42-52%) felt that "cleaning up the environment" was most important compared to such local issues as parks (15-19%) or hiding of facility (5-8%). The general consensus towards upgrading or expansion of the facilities was cautious acceptance.

Residents near Carkeek Park did not generally disagree with the location of the Carkeek Park facility, but those at Alki thought such prime land as Alki Point should not be wasted on a sewage treatment facility. Most residents interviewed at West Point said they were not opposed to the location of the facility, nor did they oppose landfill to expand the facility (54% not opposed to 24% opposed) (HRPI, 1976).

TABLE 2-15

MATRIX - GOALS OF
SEATTLE

to be in final EIS

HRPI (Metro's socioeconomic consultant for the EIS) and Metro's community involvement staff conducted informal meetings which were attended by citizens explicitly concerned about the water treatment facilities. In general, this group felt more strongly than those randomly interviewed by Gerhardt Research, that these facilities were not well located. Those at West Point, Carkeek Park, and Alki felt that wastewater facilities should not be in prime park land, but rather in industrial regions. The residents adjacent to the Richmond Beach facility, which is not park land, were not opposed to its presence. All groups were willing to put up with the facilities, and felt that monetary constraints hindered relocation. The question of expansion was debated both ways - people seemed to either strongly favor it or oppose it. Richmond Beach residents, again, were more favorable than others. At West Point there was sentiment that if expansion occurred, the West Point facility's placement would be more permanent, and there would be less chance of phasing out the use of this prominent point for a wastewater facility. At West Point, residents also complained that the fence north of the treatment facility was too close to the beach, so at high tide people could not use this beach. There was also opposition to the sludge lagoon at West Point.

Most were unaffected by the sludge trucks, but some were opposed to their noise on residential streets.

Most groups interviewed were supportive of "Metro's effort to make treatment of waste overflow at 200 places in the interceptor lines at least as high a priority as the federal and state requirement of secondary treatment". Those representing the West Point area said "Seattle residents would probably be willing to pay for 'some' extra on their sewer bill to alleviate this problem". Alki residents didn't know if they supported the Metro strategy, and didn't want to "pay any more for Metro to do the job it agreed to do" (HRPI, 1976; Clear Water Watch, 1976).

The Commodore Way site in Interbay is a distinct business community related to the seafood industry. These businesses depend on each other and on tourists who visit the fish markets in this area for their commerce. Business persons are upset that this site is even being considered for a sewage treatment facility. A petition with 1200 signatures has been formed in opposition to using this site.

Cultural Activity Centers

Cultural activity centers in the Seattle region include downtown Seattle, the University of Washington, the Seattle Center, the waterfront area, and the new King Dome Center, to mention only a few. Numerous ethnic or culturally distinct neighborhoods and sections of the Seattle community exist which provide uniqueness to the entire region. Action by Metro concerning wastewater treatment could affect the various important water bodies and shorelines and, therefore, affect their value as cultural entities.

Archeological and Historical

Historical sites in the vicinity of the proposed wastewater facilities and affected water bodies include the Alki Point Lighthouse and Hiram Chittenden Locks. Further, the West Point Lighthouse is being proposed for the historical register (Metro, 1977). Currently, the wastewater treatment facilities do not conflict with these historical sites and future expansion of the facilities could occur in such a way as not to conflict. The National Register of Historical Places also lists sites in inland areas. If interceptor routing or other wastewater related activity occurs in the vicinity of these sites, appropriate consideration should be given. These historical sites are shown in Appendix F.

Twenty-three archeological sites have been identified in King County. However, state regulations ban their publication to avoid theft and vandalism. These 23 sites are based on a very preliminary type of information and it is expected that the number will significantly increase as additional specific surveys are performed. The Office of Public Archeology at the University of Washington reviewed six alternative treatment plant sites (West Point, Commodore Way, Golf Park, Carkeek Park, Richmond Beach and Alki) and determined that no known archeological resources existed at any of the six sites. However, it was concluded that the North Beach area of the West Point site was a potential area of archeological resources and should be explored further before construction activities (Jerry Jermann, 1976).

The three alternative sites at Duwamish are all of potential interest. Many of the potential interceptor routes in northern King County and southern Snohomish County are potential archeological resources.

Health and Safety

Health and safety considerations relative to the Metro Facility Plan include:

- Occupational safety
- Public health and safety related to the various treatment facilities
- Existing health effects of combined sewer overflows
- Sludge handling
- Various construction areas such as the storage and transport of explosive or caustic chemicals

The Metro and national injury rates for sewage systems are to be commended. Metro's occupational safety record is good compared to national rates for sewage systems workers and are generally in compliance with all applicable regulations. Two hazardous conditions currently exist. First, an open flame boiler exists between the sludge digesters at Alki and, second, there are a few non-explosion proof lights in access wells at pump stations (Metro, 1976).

Health problems related to water quality have arisen at some public beaches: public health bathing standard excesses of coliforms have been cited at eleven Lake Washington beaches but the beaches have never been closed (Metro, 1976).

Combined sewer overflows may create public health problems at a number of locations, particularly in Puget Sound, the Duwamish estuary, the Lake Union/Ship Canal, and Lake Washington. During storm periods when urban runoff is discharged into many portions of the Seattle sewer system, the sewers overflow and discharge urban runoff and raw sewage into the receiving waters associated with the overflow point. The City of Seattle has embarked on a major effort entitled Forward Thrust Separation Program, to alleviate the worst of these problems. Approximately 110 (30 Metro and 80 City of Seattle) overflow outfalls remain in the system and discharge approximately 40 times annually. The current information on this subject is presented in other parts of the report and will not be expanded upon further.

The public health and water quality implications of sludge handling are described in the sludge management and groundwater portions of the report. Two types of contaminants are of interest: pathogens such as bacteria, fungi, parasites and viruses in one category; and heavy metals and complex organics in the other. Metro has spent 0.5 million dollars on sludge research since 1973. Metro's sludge disposal areas are currently protected from public access, either through fencing or remoteness. At Cedar Hills sanitary landfill, sludge leachate monitoring and control is being developed.

Another public health concern relates to septic tank failures. The health departments of King and Snohomish Counties have identified the following areas as subject to frequent septic tank failures.

1. King County East District; Welcome Lake, the east side of Lake Sammamish;
2. King County North District; Appletree Point; Five-Way Agreement Area; Flamingo Estates; Maplewood Terrace; N.E. 180th near Bothell Way N.E.; Orlands; Wellington Hills; Beardsley Blvd. near Highway 405; Cottage Lake;
3. Snohomish County South District; south of Alderwood Manor; valley bottoms along Swamp Creek; north of March Lake; south and west of Lake Serena.

Legal and Institutional Considerations

A number of legal and institutional considerations or constraints are pertinent to the Metro 201 Facility Plan. The most important of these are the goals and compliance specifics of PL 92-500 (the Federal Water Pollution Control Act Amendments of 1972). The Metro 208 Area Wide Waste Management Plan and septic tank failure problems are other constraints. Also to be considered are the various shoreline management regulations which originate from the State Shoreline Management Act. Various state regulations concerning public health and pollutant discharge permits are of concern as is the dredge and filling permit program of the U.S. Army Corps of Engineers along with the institutional considerations related to intergovernmental procedures and relationships.

Public Law 92-500 (PL 92-500)

The most significant legal constraint applicable to the Facilities Planning process is PL 92-500. The basic objective and goals of PL 92-500 are in Section 101 (a).

"The objective of this Act is to restore and

> maintain the chemical, physical, and biological integrity of the nation's waters. In order to achieve this objective it is hereby declared that, consistent with the provisions of this Act -- (1) it is the national goal that the discharge of pollutants into the navigable waters be eliminated by 1985; (2) it is the national goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by July 1, 1983..."

In Section 301(a) the provisions for limiting effluent quality are stated.

> "Except as in compliance with this section and sections 302, 306, 307, 318, 402, and 404 of this Act, the discharge of any pollutant by any person shall be unlawful."

The implementation of this ban was established in Section 402 which provides for a permit system for pollutant discharges (National Pollutant Discharge Elimination System - NPDES).

Subsections 301 (b)(1)(B) and 301 (b)(1)(C) pertain to effluent limitations for 1977. The first paragraph is the secondary treatment requirement which provides that in order to carry out the objective of this Act there shall be achieved:

> (B) for publicly owned treatment works in existence on July 1, 1977, or approved pursuant to Section 203 of this Act prior to June 30, 1974 (for which construction must be completed within four years of approval), effluent limitations based upon secondary treatment as defined by the Administrator pursuant to Section 304(d)(1) of this Act;...

The second paragraph applies to discharges into waters which will not meet quality standards through the secondary treatment requirements of paragraph B. These waters are known as "water quality limited" waters or segments. In them, law requires that there shall be achieved:

> (C) not later than July 1, 1977, any more stringent limitation, including those necessary to meet water quality standards, treatment standards, or schedules of compliance, established pursuant

> to any State law or regulations (under authority preserved by Section 510) or any other Federal law or regulation, or required to implement any applicable water quality standard established pursuant to this act.

The meaning of the 1977 secondary treatment requirements is spelled out in the regulations. For effluent limited segments which can achieve applicable standards through the use of secondary treatment, the requirements of secondary treatment are listed in 40 CFR 133.

Effluent limitations have also been established for 1983 in Section 301(b)(2)(B). These require that there shall be achieved:

> (b) not later than July 1, 1983, compliance by all publicly owned treatment works with the requirements set forth in Section 201 (g) (2) (A) of this Act.

Section 201(g)(2)(A) establishes prerequisites for grants for construction of treatment works. Specifically, the grant applicant must satisfactorily demonstrate to the EPA Administrator that:

> (A) alternative waste management techniques have been studied and evaluated and the works proposed for grant assistance will provide for the application of the best practicable waste treatment technology over the life of the works consistent with the purposes of this title: ...

The preceding clauses in Section 201(g)(2) set a deadline of June 30, 1974 after which no grants may be given for construction of treatment works which fail to comply with the requirements for study of alternative techniques and selection of the best practicable waste treatment technology."

Section 302 (b)(2) of the Act permits a variance under certain conditions for effluent limits set to meet the fishable, swimmable water quality requirements in Section 302(a).

> "If a person affected by such limitation demonstrates ...there is no reasonable relationship between the economic and social cost and the benefits to be obtained..., such limitation shall not become effective."

The National Pollutant Discharge Elimination System is a permit which provides a time schedule for compliance with PL 92-500. The original permit issued by the EPA and DOE required that Metro develop a Facility Plan by April 1, 1977 leading toward the secondary treatment requirement by July 1, 1977.

Metro complied with the part of developing a Draft Facility Plan, but because of delays in grant funding and facilities planning and questions concerning the effectiveness of secondary treatment for Metro plant's discharging to Puget Sound, secondary treatment was not established by 1977 as required by PL 92-500. Currently, DOE and EPA are in the process of preparing a new NPDES for 1977-1982; the time schedule for which this permit will require compliance with the secondary treatment required by PL 92-500 is uncertain. Alternatives A,B,C,and D will not comply with the requirement of secondary treatment. Implementation of Alternatives E, F, G, and H may require more time than available with the deadlines established in the new NPDES.

Fines for noncompliance with PL 92-500 are established as follows:

Section 309(d) of the Federal Water Pollution Control Act sets a maximum civil penalty of $10,000 per day of violation. Although the statute sets are maximum, it provides no guidance as to what would be an appropriate penalty for a particular violation.

In arriving at the estimated judgment figure. a number of factors should be considered (EPA Memorandum, 1977).

(1) The extent to which the defendant may have profited by failing or delaying to comply,

(2) The degree of harm to the public caused by the defendant's failure to comply,

(3) The willfulness of the violation, or the good or bad faith of the defendant in meeting its obligation to comply,

(4) The necessity of vindicating the authority of EPA,

(5) The ability of the defendant to pay the penalties.

To date, no municipality has been fined for noncompliance with secondary requirements.

Shorelines Management

The Shorelines Management Master Programs for Seattle and King County are major constraints on development activity within 200 feet of the significant shorelines within the city. Significant shorelines are defined as rivers and streams with flows greater than 5 cfs, lakes greater than 20 acres, and all marine waters. This includes all of the sites considered in the eight alternatives evaluated.

Other Considerations

Other important quasi-legal, political and intergovernmental considerations or issues which affect the actions that may be proposed by Metro are as follows:

- The City of Seattle's concern regarding future interceptor service to outlying, undeveloped areas and the equity of user charges for future growth areas.
- King County's recent actions concerning the preservation of agricultural land.
- The "Goals and Policies for Regional Development" and general policy impetus by the Puget Sound Council of Governments to utilize areas presently containing the needed utilities including sewers before new areas are developed (future interceptor service).
- The cost effectiveness and applicability of the federal regulation requiring secondary treatment for Metro municipal wastewater treatment plants which discharge to Puget Sount (currently being examined and resolved by the EPA and Metro).
- The current reluctance of the Washington Department of Ecology to allow the ocean dumping of sewage sludge and their discouragement of the discharging of wastewater effluent into the freshwater lakes (Washington and Sammamish).

While some of the above considerations are not written policies or regulations, they can have the same effect as specific regulatory provisions and should at least be considered in the selection and implementation of a wastewater treatment program. Due to the complex interagency review processes such as the A-95 federal project review process, local and state jurisdictions can exert a strong veto power over federal-related projects not in compliance with written or unwritten policies and value judgements.

Existing Environmental Conditions

Aesthetic Considerations

Asethic considerations have been dealt with in detail for the four treatment plant locations of West Point, Alki, Carkeek Park and Richmond Beach (Metropolitan Engineers, 1976). This information is summarized in the Appendix to Task D3 of the Facility Plan (Metropolitan Engineers, 1976). Regional considerations not taken into account in that report include the overall aesthetics of the Puget Sound, Lake Washington, and Lake Sammamish shorelines, the forested and/or pastoral nature of much of the undeveloped land which could be affected by future interceptor service and the aesthetics related to the Kenmore, South Lake Sammamish, Duwamish and Interbay sites (all of which are considered in the eight alternatives). In general, the overall aesthetics of the Puget Sound, Lake Washington and Lake Sammamish are excellent. The forested and agricultural undeveloped areas are also very important components of the total environmental quality of the Puget Sound region. In this environmental impact analysis the aesthetics associated with these areas are considered to be of the highest quality and deserving of the utmost protection. Since interceptor service to new growth areas is not defined as part of the eight alternatives in the Draft Facility Plan, the analysis of aesthetic impacts related to the important interceptor routes and pump station locations is not possible at this time. However, when future interceptor expansion is proposed, aesthetics should be an important consideration.

CHAPTER III

ALTERNATIVES AND IMPACTS

The following sections describe the eight regional alternatives and their expected environmental impacts. A brief description of existing wastewater facilities within the Metro study area provides a frame of reference for the following discussion on selection of alternatives. Next, a summary of the methodology used to analyze environmental impacts is presented. Each regional alternative, as outlined in the Draft Facility Plan (Metropolitan Engineers, 1977), is then described in more detail. Expected impacts of each alternative on the physical environment, the biological environment, the human environment, and natural resources and energy are discussed. The direct or primary impacts attributed to the alternative are presented first, followed by the indirect or secondary impacts. Mitigation measures to alleviate or lessen adverse impacts are described, followed by a list of unavoidable adverse impacts. A summary of regional impacts concludes Chapter III.

EXISTING WASTEWATER FACILITIES

The existing wastewater facilities in the Metro service area are described briefly for later comparisons with proposed alternatives for the year 2005. The facilities are presented in terms of service areas, treatment plants, collection system and combined sewer overflows, sludge management, and the Renton plant (not included in the proposed facilities plan but affected indirectly by various alternatives). Figure 1-2 summarizes existing facilities.

Service Areas

Boundaries of the planning area in the Facility Plan were determined following consideration of previously established boundaries described in the 1958 Metro Comprehensive

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Plan, the 1974 River Basin Coordinating Committee (RIBCO) study, and in various boundary adjustments developed by Metro staff and approved by the Metro Council.

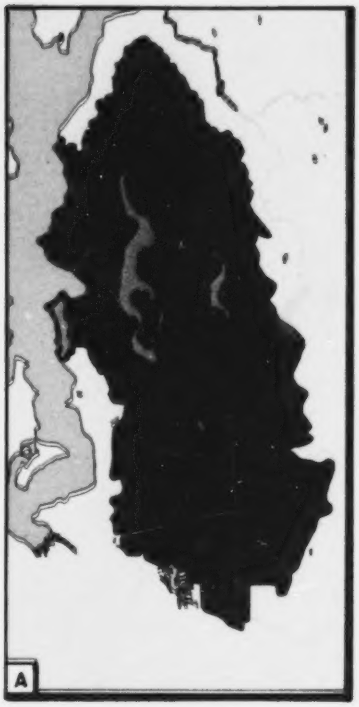
A premise in the original Comprehensive Plan was the division of the area into logical units for sewerage, drainage and design. This division was based on many factors which, in the case of sewerage planning, were limited and defined by topography as well as economic and political considerations. Therefore, boundaries of the original metropolitan Seattle sewerage study were established on the basis of topography, growth, and development studies.

The planning area boundary was revised during the RIBCO environmental management study to generally follow the drainage basin concept; it included the upper watershed of the Cedar and Green Rivers. Areas requiring sewer service before the year 2000 (according to IRDP-AAM projections) were identified within the RIBCO basin boundary and followed, with a few modifications, in the Draft Facility Plan.

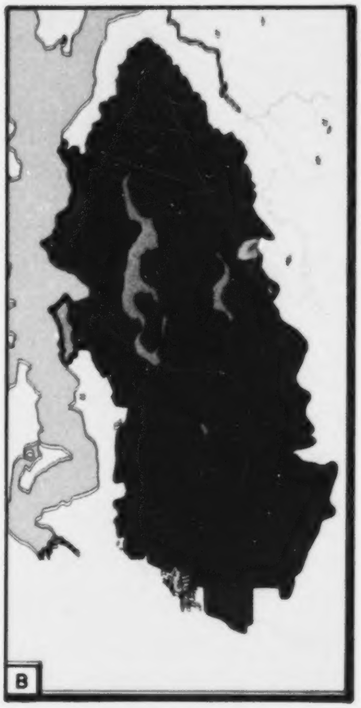
Boundaries used in the Draft Facility Plan are shown in Figure 3-1. The planning area in general is defined by the shoreline of Puget Sound from Seattle north to the Snohomish County line, east into Snohomish County following the natural drainage, south following the original Comprehensive Plan boundary to a point about two miles northeast of Issaquah, where the line begins to cut across the natural drainage at the location where land development is expected to cease. This line generally follows the City of Seattle watershed fence line and rail lines to the northern edge of Enumclaw, then west to the northern shore of Lake Tapps. The boundary then proceeds north following the RIBCO boundary in southwestern King County adjacent to southwest suburban Des Moines and Lake Haven sewer districts (with the exception of the unincorporated Star Lake area, which is to be sewered into the City of Kent).

The total Metro study area encompasses approximately 710 square miles, as shown in Figure 1-1. Approximately 275 square miles comprise the primary study area for the Facility Plan, shown in Figure 1-1; this includes the drainage basins tributary to the West Point, Alki, Carkeek Park and Richmond Beach plants. The large Renton service area (435 square miles) is excluded from the primary study area, although Renton area considerations are included in many elements of the planning.

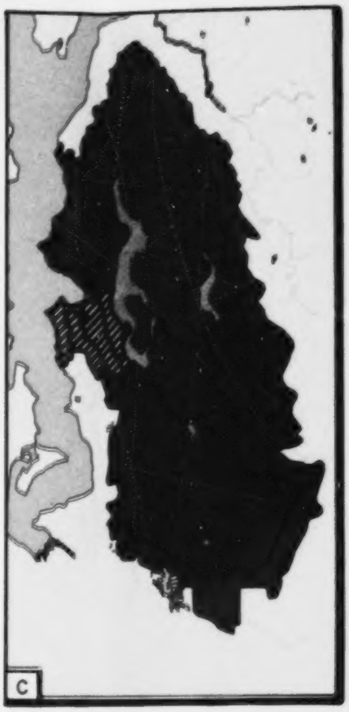
Although most of the projects involved in the Draft Facility Plan are within the West Point, Alki, Carkeek Park and Richmond Beach service areas shown in Figure 2-1, some



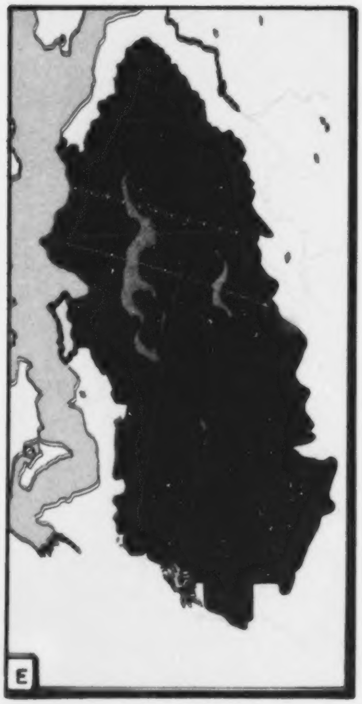
NO ACTION



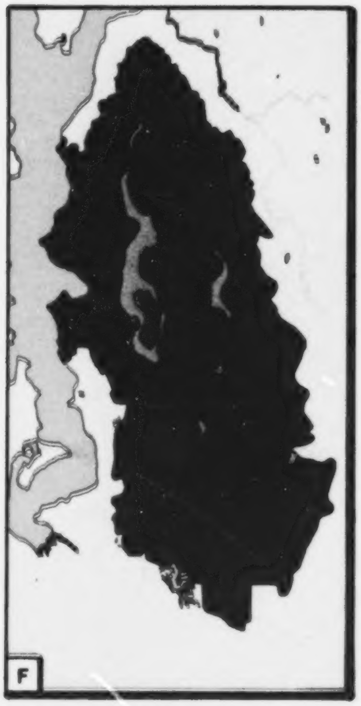
COMPREHENSIVE PLAN
(NO ACTION PURSUANT
TO PL 92-500)



MAJOR CSO CONTROL



SECONDARY



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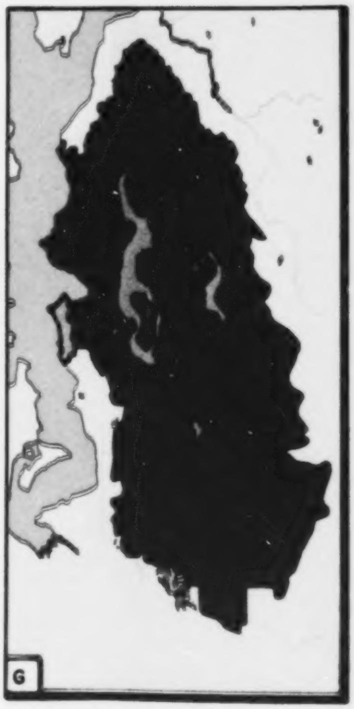
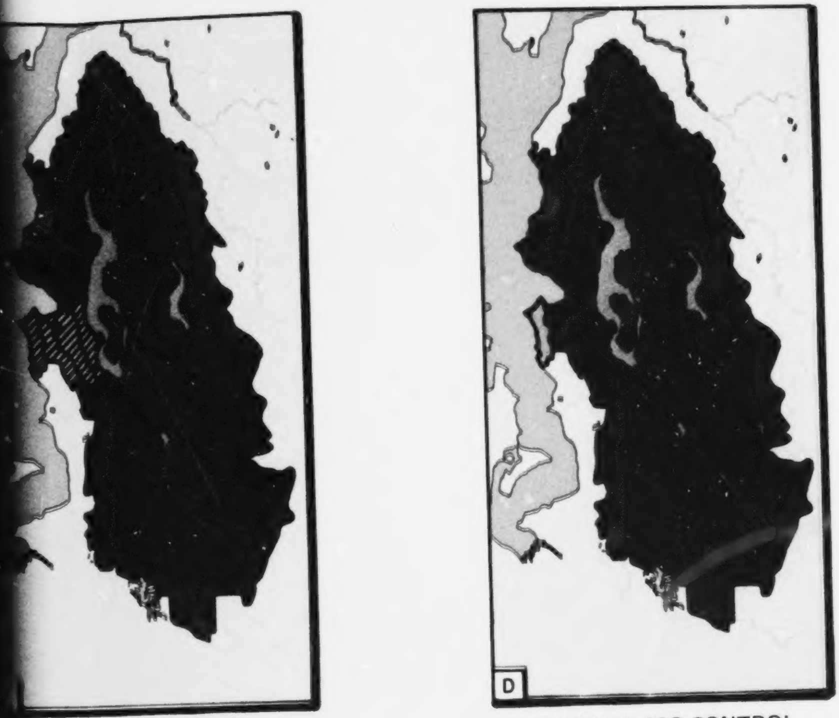
SOUTHERN STRATEGY



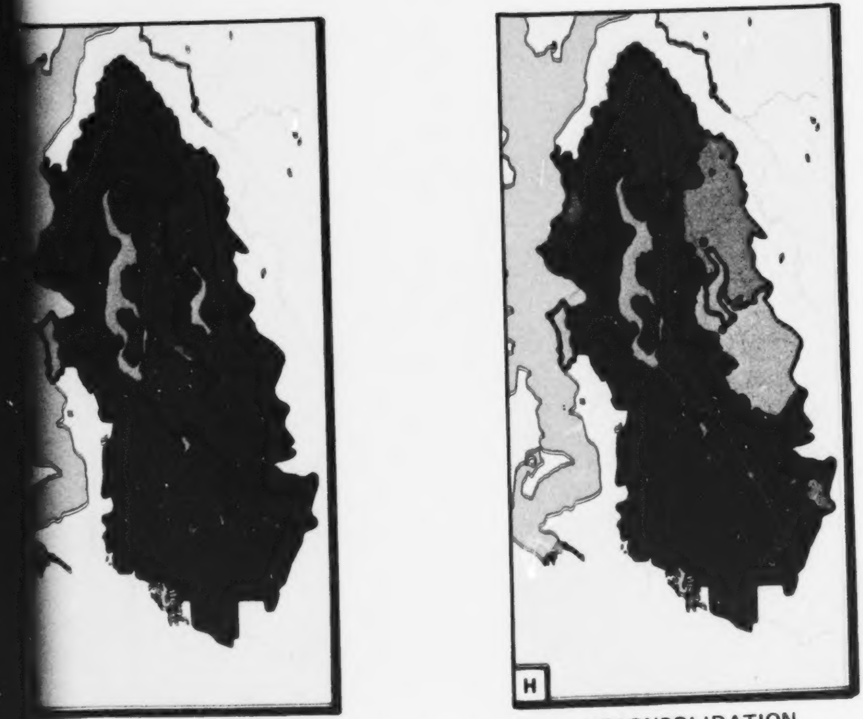
SECONDARY
WEST POINT PHASE OUT
OPTION

A



MAJOR CSO CONTROL

PARTIAL CSO CONTROL



SECONDARY
WEST POINT PHASE OUT
OPTION

DECONSOLIDATION
RECLAMATION

LEGEND

- ■ RENTON
- ■ WEST POINT
- ▨ DUWAMISH (STORMWATER)
- ■ DUWAMISH (WASTEWATER)
- ▒ ALKI
- ■ RICHMOND BEACH
- ■ CARKEEK PARK
- ■ NORTH LAKE WASHINGTON
- ■ NORTH LAKE SAMMAMISH
- ▒ SOUTH LAKE SAMMAMISH
- ▨ PRESENTLY SERVED BY OTHERS

- ● WASTEWATER TREATMENT PLANT
- ○ STORMWATER TREATMENT PLANT

Figure 3-1

Metro 201 Facility Plan
Service Area Alternatives

B

regional issues extend beyond these boundaries. Sludge disposal, the environmental impacts of the alternatives on water quality, and the secondary impacts on the Renton service area are examples.

The existing service area divisions are the same as shown for Alternative A, No Action. Figure 3-2 illustrates the sewerage service subareas.

Treatment Plants

The average daily flow for the Puget Sound plants, as described in the Draft Facility Plan (Metropolitan Engineers, 1977) from 1973-1975 daily records, was 118 million gallons per day (mgd) from West Point, 7.5 mgd at Alki, 3.4 mgd at Carkeek Park, and 1.5 mgd at Richmond Beach. Details on average and peak flows are discussed in the Draft Facility Plan.

Operation of the four Puget Sound plants is centralized under the West Point division. More detailed discussions on operations and the existing unit processes at the Metro primary treatment plants can be found in the Draft Facility Plan and site-specific EIS documents.

The four Metro treatment plants discharging effluent to Puget Sound currently provide primary treatment for wastewater. Primary treatment is a general term encompassing coarse screening, grit removal, influent solids sedimentation with skimming of floatables, and sludge disposal.

The only liquid stream leaving the Metro treatment plants is effluent from wastewater treatment. Small volumes of this effluent are sometimes treated further and used on the plant grounds for lawn and shrubbery irrigation and fertilization, but the major portion is discharged to Puget Sound through submarine outfalls. Three of the outfalls (at Richmond Beach, Carkeek Park, and West Point) were designed concurrently. The Alki plant and associated outfall were designed and constructed independently at an earlier date.

The general dimensions of all four outfalls and their locations are shown in Table 3-1.

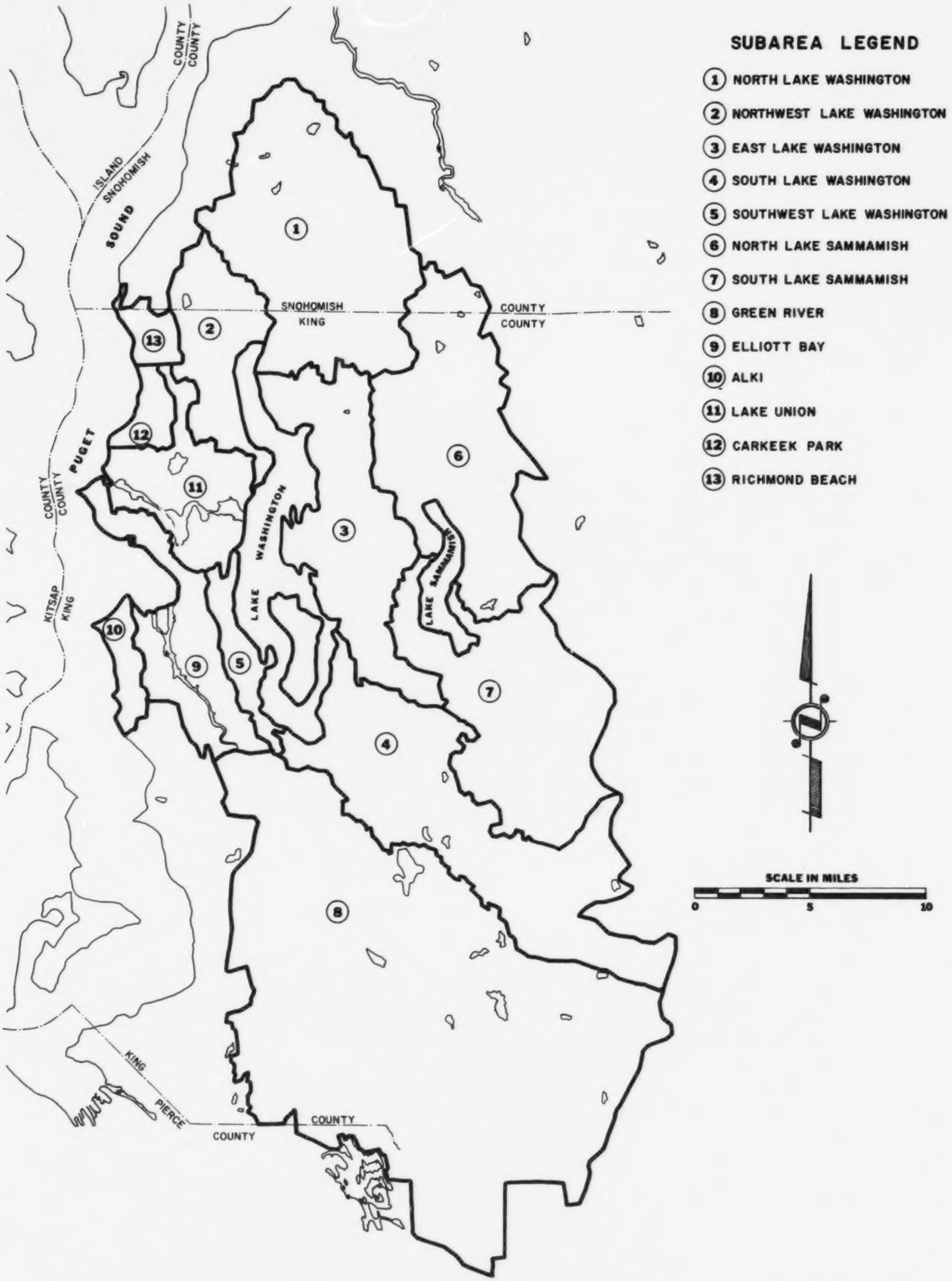

SUBAREA LEGEND
① NORTH LAKE WASHINGTON
② NORTHWEST LAKE WASHINGTON
③ EAST LAKE WASHINGTON
④ SOUTH LAKE WASHINGTON
⑤ SOUTHWEST LAKE WASHINGTON
⑥ NORTH LAKE SAMMAMISH
⑦ SOUTH LAKE SAMMAMISH
⑧ GREEN RIVER
⑨ ELLIOTT BAY
⑩ ALKI
⑪ LAKE UNION
⑫ CARKEEK PARK
⑬ RICHMOND BEACH
SCALE IN MILES
0
5
10
ISLAND COUNTY
SNOHOMISH COUNTY
SOUND
PUGET
SNOHOMISH COUNTY
KING COUNTY
KITSAP COUNTY
KING COUNTY
LAKE WASHINGTON
LAKE SAMMAMISH
KING COUNTY
PIERCE COUNTY

FIGURE 3-2 SEWERAGE SERVICE SUBAREAS

TABLE 3-1

OUTFALL DETAILS

Plant	Peak Cap. (mgd)	Length (ft)	Max. Depth (ft)	Dia. (in)	Diffuser Ports No.	Diffuser Ports Diameter (in)	Diffuser Ports Spacing (ft)
Richmond Beach	10	1,600	110	30	10	6.5	5
Carkeek Park	20	2,100	200	33	12	5.5, 6 & 7	4
West Point	325	3,650	240	96	200	4.5, 5.0 & 5.75	3
Alki	30	1,400	80	42		none	-

Receiving waters which may be affected by Metro's sewerage system are monitored in a Metro program which began in 1961 and has had the cooperation and approval of a review board appointed by the State Department of Ecology. More than 600 monitoring stations measure a variety of physical, chemical, bacteriological, and ecological parameters. These stations are located in all waters which may be affected by Metro's operations. Parameters monitored include coliform bacteria, dissolved oxygen, toxicant concentration, benthic conditions, and productivity.

Collection System and Combined Sewer Overflows

The collection system in the planning area varies in age, material of construction, and condition. The first sewers in the area were constructed within the limits of the City of Seattle in the 1880's. In addition to the transfer of domestic and industrial wastewaters, the collection system was built to provide a convenient available conduit for a variety of waters, for which disposal was required to prevent localized problems. These waters included storm related surface runoff, subsurface embankment drainage, structure foundation drains, reservoir drainage, and lake flushing waters.

Originally, the collection system discharged raw sewage into Lake Washington, Lake Union, the Duwamish River, and

Puget Sound. Later in the 1930's, some of the raw sewage discharges to Lake Washington were intercepted and treated at localized treatment plants (consisting of Imhoff tanks) or diverted to saltwater. However, combined sewer overflows during rainy periods and poor quality effluents from the treatment plants continued to degrade the water quality of Lake Washington. The raw sewage discharge to saltwater increased pollution along the waterfronts.

With the establishment of Metro and the adoption of the Comprehensive Plan in 1958, Metro became responsible for transporting the sewage collected by the local agencies to one of the Metro sewage treatment facilities. Since then, Metro has also assumed control of some existing facilities and constructed new facilities to implement the comprehensive wastewater treatment plan. Currently, Metro serves 33 cities and special districts which provide the basic operation and maintenance services for the local collection systems. Metro's facilities include major interceptors, pump stations tunnels, and siphons.

In addition to the pump stations and various transport systems, Metro employs a storage and diversion system for its wastewater flows. This system of in-line storage and regulation known locally as the computer augmented treatment and disposal system (CATAD), reduces the volume and frequency of combined sewer overflows. CATAD consists of 17 existing regulator stations in the West Point service area which have the capability to store wastewater flows in their immediately preceding upstream interceptor sewers. This regulated storage is employed during rainstorms to permit flows in excess of the treatment plant capacity to be stored and then released slowly to the plant as the storm flow subsides. The system reduces the number of combined sewer overflow occurrences per year. Figure 3-3 shows the location of the CATAD regulator stations and drainage areas.

Reduction of combined sewer outflow is affected also by the City of Seattle's partial sewer separation program. The program was initiated in 1968 and financed by $75 million in Forward Thrust funds plus $6 million in Metro funds.

Before separation, the city had a total of 1,413 miles of combined sewers and about 105 combined sewer overflows or outfalls which discharged a mixture of raw sewage and stormwater into Lake Washington, Lake Union and the Ship Canal, Green Lake, the Duwamish River estuary, Elliott Bay and Puget Sound. It is estimated that 57 percent, or 807 miles, of the total combined sewers were overloaded and would flood during heavy rainfall. Completion of the Forward Thrust separation program will result in the construction of 274 miles of new storm

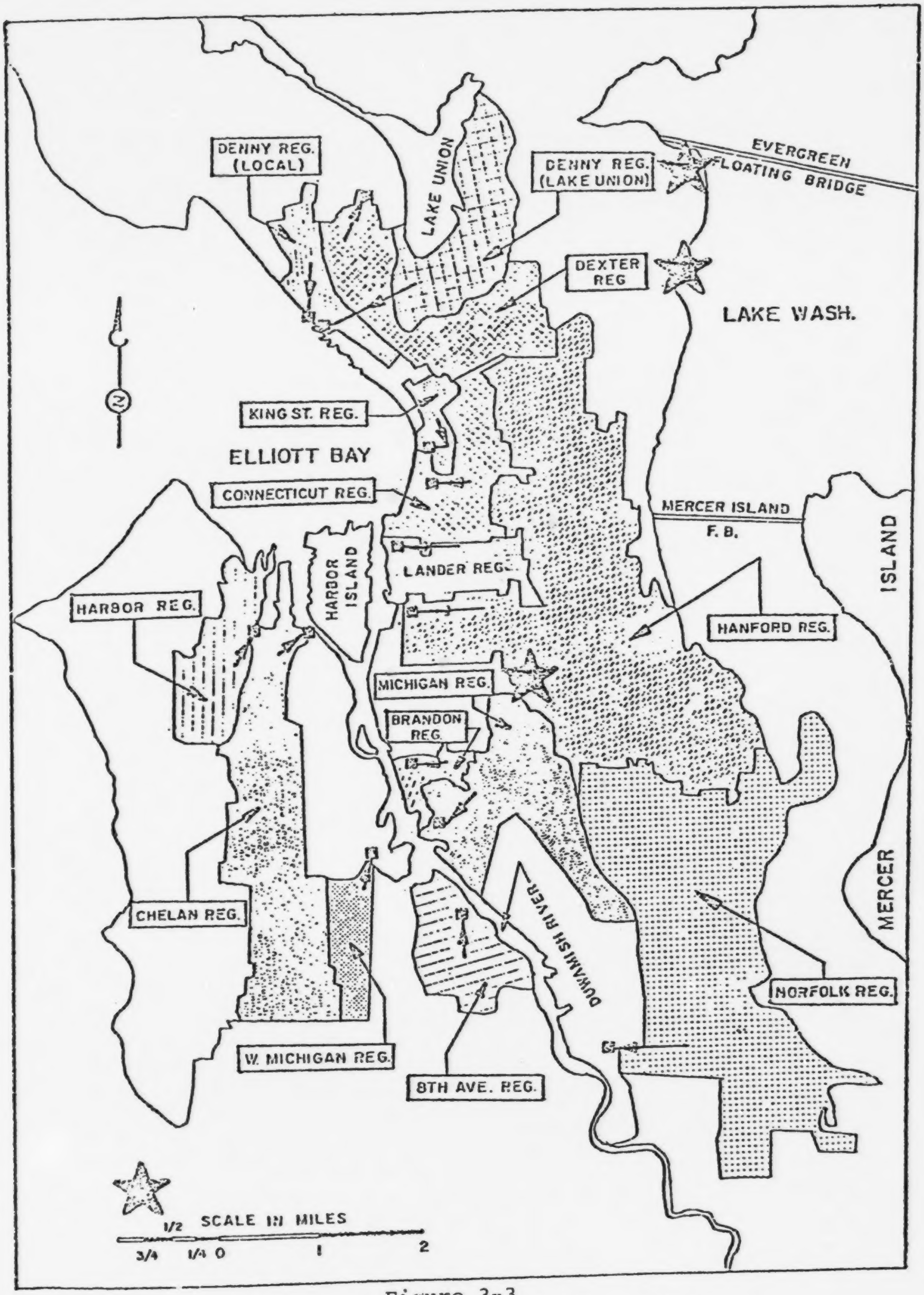

DENNY REG. (LOCAL)
LAKE UNION
DENNY REG. (LAKE UNION)
EVERGREEN FLOATING BRIDGE
DEXTER REG
LAKE WASH.
N
KING ST. REG.
ELLIOTT BAY
CONNECTICUT REG.
MERCER ISLAND F. B.
LANDER REG.
HARBOR ISLAND
HARBOR REG.
HANFORD REG.
ISLAND
MICHIGAN REG.
BRANDON REG.
CHELAN REG.
DUWAMISH RIVER
MERCER
NORFOLK REG.
W. MICHIGAN REG.
8TH AVE. REG.
SCALE IN MILES
1/2
3/4
1/4
0
1
2

Figure 3-3
CATAD REGULATOR STATIONS AND
DRAINAGE AREAS

drains and 54 separate stormwater overflow outfalls, with a corresponding relief on the remaining sewer lines and overflow structures. Out of a total of 50,576 sewered acres in the city, 18,000 acres will be separated by this phase of the program, including all of the area draining to Lake Washington.

Overflows occur in the Seattle area at 110 different locations, of which 30 are listed under Metro NPDES permits and the remainder are the responsibility of the City of Seattle. Despite the presence of two jurisdictions, the system functions as one entity.

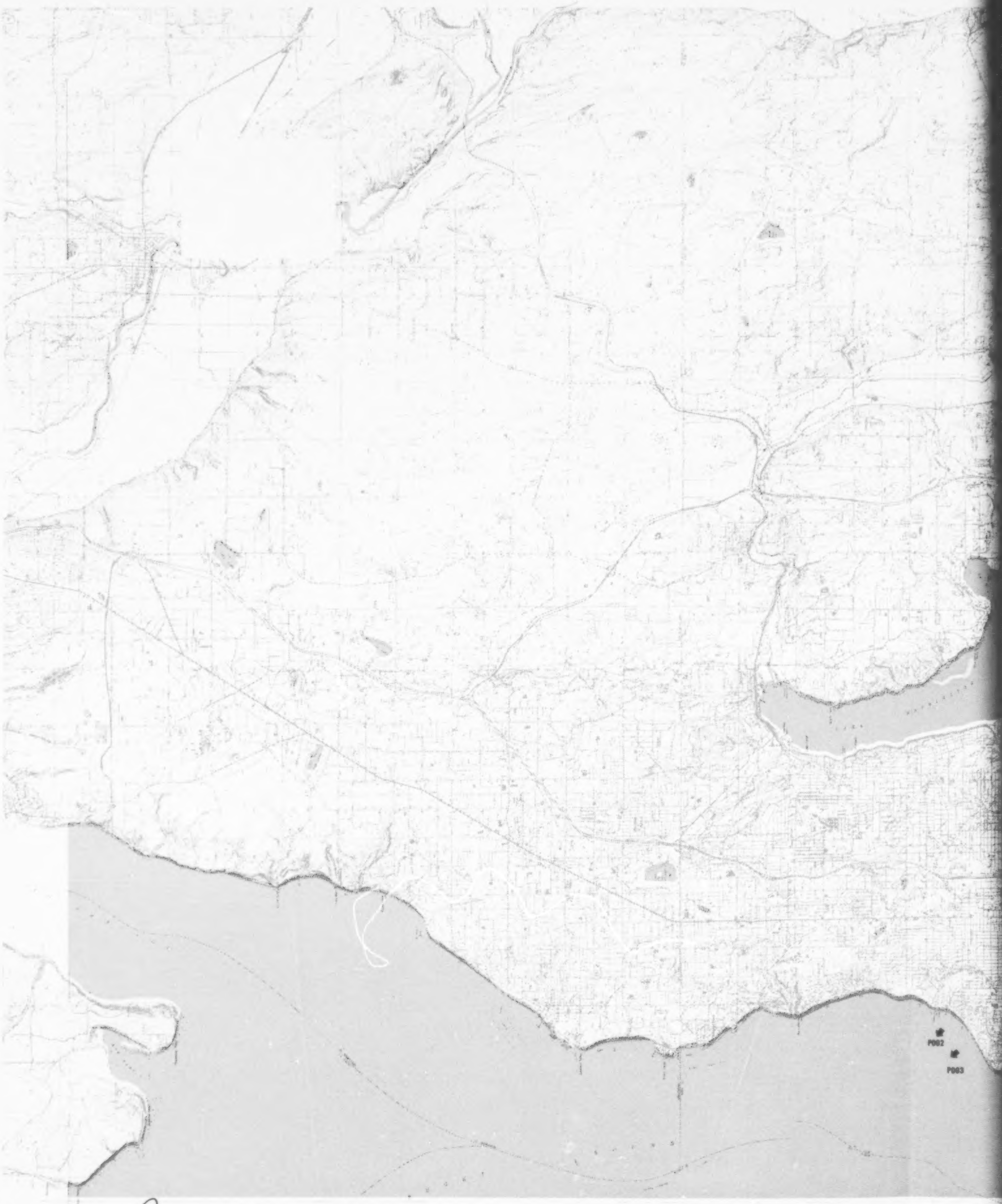
Figure 3-4 shows the location of combined sewer overflows in the Seattle area. Table 3-2 tabulates the estimated annual volumes of overflows into the various receiving water bodies.

The volume of combined sewer overflows discharged through an overflow structure depends primarily on the duration and intensity of the rainstorm as well as the size and capacity of the collection system downstream of the structure. Other factors which affect the overflow volume are the time of day, the season, and the period of time since the last storm occurred.

Sludge Management

The solids produced by municipal wastewater treatment include grit, screenings, and sludge. Sludge is the largest in volume of these three; its processing and disposal is one of the more complex problems faced in the field of wastewater treatment. The problems of handling raw sludge are complicated by the high moisture content (95-98%), which results in large volumes. Since sludge contains most of the pollutant materials of greatest concern (such as stable organics, nitrogen, heavy metals, oil, phosphorus and pathogens), its potential impact on public health and the environment during processing and final disposal must be considered in planning alternatives.

Six basic disposal methods have been utilized by Metro over the past ten years. These include deep water disposal, sanitary landfill disposal, soil rehabilitation, beach front earth fill, disposal on forest land and disposal on agricultural land. A summary of Metro sludge disposal experience, and the range of land application options available to Metro are presented in the Draft Facility Plan.



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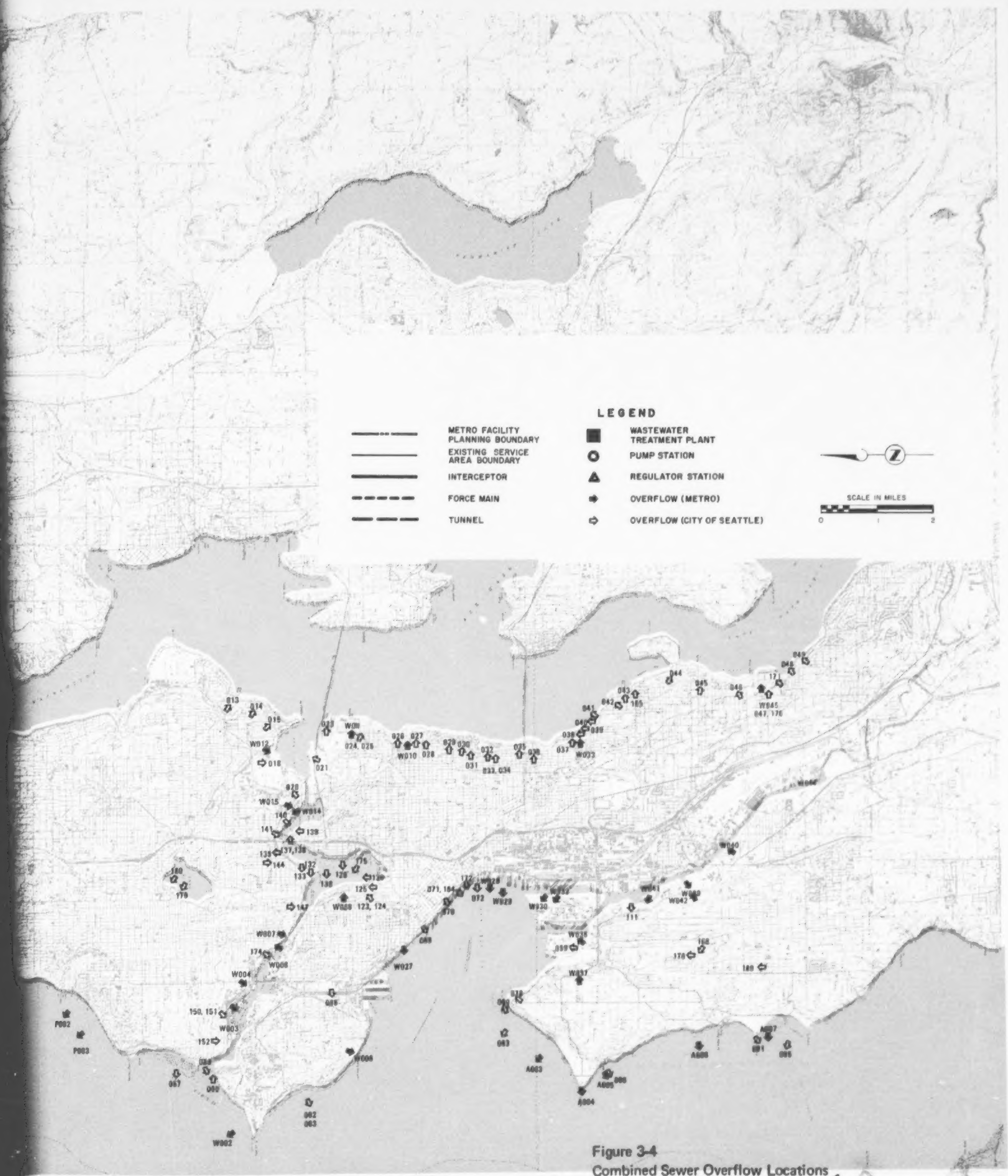

LEGEND
METRO FACILITY PLANNING BOUNDARY
EXISTING SERVICE AREA BOUNDARY
INTERCEPTOR
FORCE MAIN
TUNNEL
■ WASTEWATER TREATMENT PLANT
○ PUMP STATION
▲ REGULATOR STATION
➡ OVERFLOW (METRO)
⇨ OVERFLOW (CITY OF SEATTLE)
N
SCALE IN MILES
0
1
2
013
014
015
W012
016
021
W011
024, 025
026
027
W010
028
029
030
031
032
033, 034
035
036
037
W033
038
039
040
041
042
043
185
044
045
046
W045
047, 176
171
048
049
020
W015
W014
140
141
138
139
137,138
144
132
133
130
129
175
126
125
123, 124
W008
142
180
179
W007
174
W006
W004
150, 151
W003
152
058
057
060
W002
P002
P003
068
W009
062
063
171, 184
172
070
069
W027
073
072
W029
W030
W031
W041
W042
W040
W039
111
W035
059
169
170
180
W037
079
080
083
A003
A004
A005
086
A006
A007
091
095
W044

Figure 3-4
Combined Sewer Overflow Locations

The general pattern of Metro sludge management is centralized treatment; all sludges from the Metro treatment plants except Alki are processed at the West Point facility. Originally, sludge was disposed to Puget Sound. This decision was made in 1965 following a review of alternative methods of digested sludge disposal that included landfill, barging, incineration, and deep water disposal through a submarine outfall. In response to the subsequent requirements of the 1965 Water Quality Act, the state of Washington issued a directive in 1971 that required Metro to cease discharge of digested sludge to Puget Sound by January 1972. As a result, Metro then provided a dewatering facility for the digested sludge to reduce its volume before hauling it by truck to the Cedar Hills landfill site.

After removal of digested sludge from Puget Sound, the Metro Council established an ongoing research policy to evaluate recycling of sludge, particularly as a soil conditioner in forest lands. Preliminary results of a feasibility study at Pack Forest, however,indicated that some potential adverse impacts such as (1) excess nutrient release into groundwater and stream systems, particularly nitrates, (2) microbial contamination, and (3) heavy metal contamination occurred. In addition there are certain engineering and economic problems associated with sludge and wastewater which must be considered. However, personnel at Metro and the University of Washington believe the problems can be managed and the recycling concept is worthwhile.

Under existing conditions, the organic solids captured in the primary sedimentation tanks at Alki, Carkeek Park, and Richmond Beach are digested separately at the three plants. The digested sludge from Carkeek Park and Richmond Beach is trucked to the Interbay pumping station for transfer to the West Point treatment plant, subsequently recaptured in the sedimentation tanks at West Point, and pumped to the West Point digester. The pumping of sludge from Interbay pumping station to West Point alleviates the additional traffic passing through Discovery Park enroute to the West Point plant. The digested sludge from Alki now goes directly, in an undewatered form, to the Cedar Hills county landfill holding basins,thus bypassing both redigestion at West Point and the West Point dewatering facilities. This is only because the solids concentration of Alki sludge is relatively high.

Raw, undigested sludges from both the primary and secondary treatment processes at Renton are also conveyed to the West Point plant by pumping through twin 12-inch diameter force mains to the Elliott Bay interceptor sewer, where the sludge mixes with the rest of the wastewater flow in that sewer and is then recaptured in the sedimentation tanks at West Point.

In addition to the organic solids from Richmond Beach, Carkeek Park, and Renton, the organic matter from the West Point system is captured in the West Point sedimentation tanks and anaerobically digested. The digested solids are then dewatered by means of a centrifuge or vacuum filter and trucked away to Cedar Hills landfill for disposal. Currently, both the digestion capacity and dewatering capacity at West Point are insufficient to cope with existing solids loadings, but a centrifuge for dewatering is on order.

The fine and coarse grit materials, primarily inorganic in nature and removed during the initial treatment steps at the five plants, are hauled by truck directly to a landfill site for disposal.

Sludge quantities from the Metro plants average about 35 tons/day of dry solids, thus amounting to about 13,000 dry tons/year. Sludge disposal costs amount to $110 per dry ton or approximately $1.4 million annually. Table 3-3 summarizes present and future estimated sludge quantities from the Metro treatment plants.

TABLE 3-3

SLUDGE QUANTITIES

	West Point	Renton	Alki	Carkeek Park	Richmond Beach
1975 (tons/day)	36*	13	1.2	0.6	0.4
2005 (tons/day)	102-143**	55-93	2.8-4.0	1.7-2.4	2.6-3.9

*West Point loads include the loads from the other four plants.

**The higher estimates are from consideration of potential lime treatment of the wastewater.

Metro's sludges are disposed of under the constraints set by the State Department of Ecology National Pollutant Discharge Elimination System (NPDES) permits, namely, that all solids shall be disposed of in a manner that prevents their entry into the waters of the state, and that leachates from the solids shall not cause any adverse effect on groundwater or surface water quality. Any proposed plan for solids disposal must be approved by the Department of Ecology.

The Metro sludge is trucked to Cedar Hills landfill, operated by King County, and located as shown in Figure 3-5. Currently, the Metro treatment plants'35 tons per day of

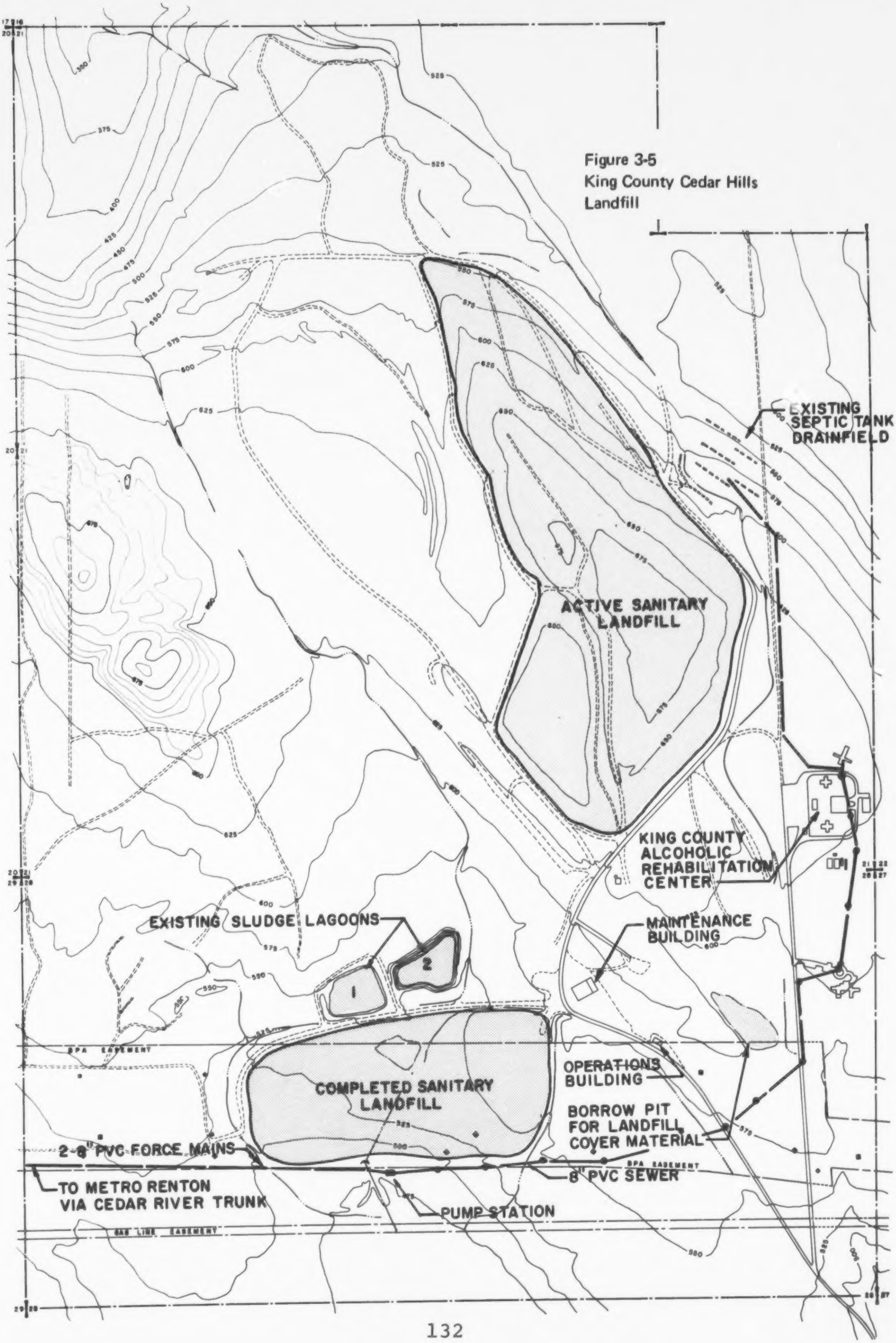


Figure 3-5
King County Cedar Hills
Landfill

EXISTING SEPTIC TANK DRAINFIELD
ACTIVE SANITARY LANDFILL
KING COUNTY ALCOHOLIC REHABILITATION CENTER
EXISTING SLUDGE LAGOONS
1
2
MAINTENANCE BUILDING
BPA EASEMENT
OPERATIONS BUILDING
COMPLETED SANITARY LANDFILL
BORROW PIT FOR LANDFILL COVER MATERIAL
2-8" PVC FORCE MAINS
BPA EASEMENT
8" PVC SEWER
TO METRO RENTON VIA CEDAR RIVER TRUNK
PUMP STATION
GAS LINE EASEMENT

sludge for landfill compares to 1,000 tons per day from municipal refuse also trucked to the site for disposal. Forty to fifty percent of the Metro sludge currently goes to the Pack Forest research site.

Renton

The Renton service area and treatment plant are not part of the proposed alternatives in the Draft Facility Plan, which addresses the four Puget Sound plants and the possible alternatives to them. However, the selection of a regional alternative will affect the Renton service area and plant, so they are described briefly here.

The Renton treatment plant is located on the Green-Duwamish River, 13 miles upstream of the river mouth. The existing service area of the plant, shown in Figure 3-1 and equivalent to that under Alternative A, extends from north of the northern King County line to Lake Tapps on the south. The plant presently serves an area of about 373 square miles, but the ultimate service area is 435 square miles. Lake Washington forms approximately 25 miles of its western border; its most easterly point is about 18 miles inland from Puget Sound. Lake Sammamish, with an area of about 4,700 acres, lies in the north-central portion; there are many smaller lakes within this service area. There are three principal rivers (the Green-Duwamish, Cedar, and the Sammamish) and numerous minor creeks and streams within this area.

Presently there are 15 incorporated cities located within the Renton service area: Redmond, Kirkland, Bellevue, Beaux Arts, Clyde Hill, Medina, Yarrow Point, Hunts Point, Mercer Island, Issaquah, Kent, Renton, Algona, Tukwila, and Auburn.

The treatment plant provides secondary treatment for the wastewater generated in the area. The design capacity of the plant is 36 mgd based on average flow, and 96 mgd peak flow. The primary treatment includes grit removal and primary sedimentation for the removal of settleable solids. Secondary treatment is by the activated sludge process, where organic matter is treated biologically and assimilated to form flocs, which are settled in the secondary sedimentation tanks. The effluent from these tanks is chlorinated for disinfection, followed by dechlorination to remove the chlorine residual prior to discharging to the Green-Duwamish River. Sludge handling facilities are not available at Renton. The raw sludge and waste activated sludge generated from the various processes are pumped to the West Point treatment plant.

For the period 1972 through 1975, the Renton treatment plant was reported to remove 75 to 98 percent of the BOD loading in the influent wastewater. Similarly, suspended solids are reduced by 39 to 97 percent. The removal figures are within the range expected for secondary treatment. Although the treatment plant has been operating satisfactorily, several treatment upsets have been experienced in the past. During summer, as the plant flow declines and temperatures rise, nitrification occurs and results in poor settleability of the sludge. During winter, with increasing flows and decreasing temperature, bulking occurs and produces poor sludge settleability.

The force main transferring sludge to West Point has been a source of operation and maintenance problems, especially during the summer months, due to the production of hydrogen sulfide. The Renton sludge also has been a major cause of treatment upsets reported at the West Point plant, due to the sludge rising in the primary sedimentation tanks. It is worth noting here that the Renton treatment plant receives the leachate from the Cedar Hills landfill. The chemical analysis of the leachate is not available; however, it is expected to contribute an appreciable amount of heavy metals and other pollutants to the Renton plant.

DEVELOPMENT OF ALTERNATIVES

The development of the regional alternatives was based primarily on four issues. From these objectives, different combinations were assembled in terms of alternatives for service area, treatment plant site, treatment process, combined sewer overflow control, collection system, water conservation, sludge management, and beneficial re-use of wastewater. The result was the description of eight regional alternatives planned to service populations until the year 2005.

Issues

Four major issues were developed in the early stage of the facilities planning process (Metropolitan Engineers, 1977). They included:

(1) Water quality

(2) The law (PL 92-500)
(3) Costs
(4) Site impacts

Other issues included decentralization and growth.

Since the number of regional alternative arrangements was so large, these issues were used to reduce that number to a manageable set. The four issues cannot be met equally by all alternatives; some trade-offs are inherent in the selection process. For example, water quality might be improved under one alterantive, but at a higher cost or with greater site impacts relative to other alternatives.

Under the first issue, water quality, the alternatives consider various types of treatment (primary, enhanced primary, secondary, advanced waste treatment) along with combined sewer overflow control. The EIS analyzes the impact of the combinations, as developed in the Facility Plan.

Under the second issue, the law, the alternatives contain two that are considered to comply with environmental requirements pursuant to SEPA and NEPA (A and B), two that do not comply with PL 92-500 (C and D) but address a local water quality problem of combined sewer overflows, and four (E, F, G and H) that provide secondary treatment pursuant to PL 92-500 requirements.

The third issue, cost, is important to Metro customers and taxpayers. Cost for wastewater facilities was a constraint in facility planning. In addition, cost is linked to the legal issue because eligibility for federal and state funding is related to compliance with PL 92-500.

The fourth issue, site impacts, was an important concern in the Facility Plan because existing plants at West Point, Alki, Carkeek Park and Richmond Beach are in park land and/or residential settings.

Local versus centralized wastewater management systems were also addressed in the selection of the alternatives in the Facility Plan since they have different implications in terms of growth, potential re-use of wastewater and sludge, and degree of treatment required. Under the present Comprehensive Plan, West Point and Renton are the major plants, treating over 90% of the wastewater generated in the Metro service area. Decentralization would provide for local plants to serve the inland areas, thus reducing the service areas tributary to West Point and Renton and increasing the potential for effluent and sludge re-use for agricultural purposes and land application.

Alternatives and Impacts

Certain alternatives were considered briefly but discarded because of overriding concerns. For example, no alternative contains tertiary treatment for the plants discharging to Puget Sound because of high costs, energy use, and the uncertain value of marginal water quality benefits. An alternative proposing complete elimination of combined sewer overflows with complete upgrading of existing facilities to secondary treatment was similarly discarded because of high costs.

Disposal methods prohibited by law were also rejected in the planning process. Ocean dumping of sludge was not considered, in order to comply with the DOE directive that required Metro to cease discharge of sludge to Puget Sound in 1972. Secondary or higher levels were considered to treat effluent discharged to inland freshwaters.

Wastewater Management System Components

The system components considered in the development of regional alternatives included service areas, treatment plants (sites, process and effluent discharge mode), collection and transfer systems, combined sewer overflow control, sludge management, pretreatment, infiltration/inflow, beneficial re-use of reclaimed water and other factors, which are presented briefly in the following discussion. Details on these and other elements of alternatives development are described in the Facility Plan.

Service Area Alternatives

Population projections for existing service areas (comparable to Alternative A in Figure 3-1) were made as described in Chapter II. Various combinations of service areas were evaluated in terms of their effect on size, number, and location of treatment plants; the process required for discharge at that location; and need for new transfer interceptors to accommodate alterations in service areas. Mitigating potential site impacts of upgraded plants was an objective of some alternatives that would reduce the service area and flow to existing plants (as at West Point) or eliminate the need for a plant entirely (as at Alki).

Although a large number of system-wide alternatives can be attained theoretically by various service area configurations and treatment plant combinations to meet different goals, the general drainage pattern of the area and the alignment of existing interceptors set by the Comprehensive Plan reduce the number of practical alternatives. Furthermore, the capital already invested in present wastewater management facilities (including treatment plants and collection systems) restricts the range of cost-effective alternatives.

Treatment Plants

Plant siting alternatives were considered since site constraints at some existing locations were identified. For example, impact on park use or residential neighborhoods, need for shoreline fill, decentralization potential, and other related topics led to considering alternative plant sites.

Treatment process. Treatment process options were major influences on alternatives development and were, in turn, affected by discharge requirements for particular types of surface waters, site constraints, costs, and legal requirements. Processes evaluated in order of increasing treatment effectiveness and cost were primary, enhanced primary, secondary, secondary plus nitrification and filtration, and advanced waste treatment.

Primary treatment, which removes approximately 60 percent of solids and 30 percent of the oxygen demanding materials (biochemical oxygen demand, BOD) from wastewater by settling, was an option for treatment prior to discharge to saltwater. Treated primary effluent would contain approximately 115 mg/l BOD and 110 mg/l suspended solids. Enhanced primary treatment, which would use chemical addition to improve effluent quality to approximately 75 mg/l BOD and 30 mg/l solids, was another option for plants discharging to saltwater. Secondary treatment, which removes 85 percent or more of solids and BOD by aeration, biological oxidation and clarification after primary treatment, was an option for discharge to saltwater and the Duwamish River. Nitrification (to remove nitrogen compounds that demand oxygen) and filtration (to remove more solids) following secondary treatment were considered for discharge to the Duwamish River. For inland treatment plants discharging to freshwater lakes or rivers, advanced waste treatment was proposed. Enhanced primary, secondary, nitrification, denitrification (to remove nitrates), granular carbon adsorption (for organics removal) filtration, and ion exchange (to remove salts) processes in series were proposed for the advanced waste treatment process.

For achieving secondary treatment standards, several different processes were considered: physical/chemical, tower trickling filters, rotating biological contactors, activated biofilters, and activated sludge.

According to the Facility Plan and related pilot plant tests, the only treatment process which could reliably meet the BOD and suspended solids requirement (85 percent removal in dry weather, 30 mg/l in effluent in wet weather) without excessive costs or the addition of an expensive second step in the process is air activated sludge. Second best for reliability and cost at the small plants is the rotating biological contactor system with chemical additions; at the large plants tower trickling filters followed by granular filtration was judged second best. Physical/chemical treatment could not meet the BOD removal objective.

Collection System and Combined Sewer Overflow

Collection system analyses of combined or separate sewers were made prior to developing alternatives. Alternatives for combined sewer overflow (CSO) control included facilities such as holding tanks, regulator stations, service area modifications, plant siting and capacity, and wet weather treatment. The regional alternatives differ in their commitment to combined sewer overflow controls. Some alternatives offer little or no improvement over the present situation; others are directed toward overflow reduction. Some alternatives would facilitate the phaseout of treatment plants at either West Point, Alki, or both.

CSO alternatives were based on a priority for control based on receiving water body sensitivity. Using a geographic inventory of water use areas, aquatic life habitats and relative risk to pollutant loadings based on physical characteristics, the Draft Facility Plan identified three levels of sensitivity in terms of pollution risk. Areas subject to CSO's and relative control priority based on risk, summarized in Figure 3-6, were used in alternatives developed.

Sludge Management

In formulating sludge management alternatives, key elements considered were the location of sludge processing facilities, degree of consolidation, process, transport methods and ultimate disposal and re-use method. The location of sludge processing is particularly influenced by the

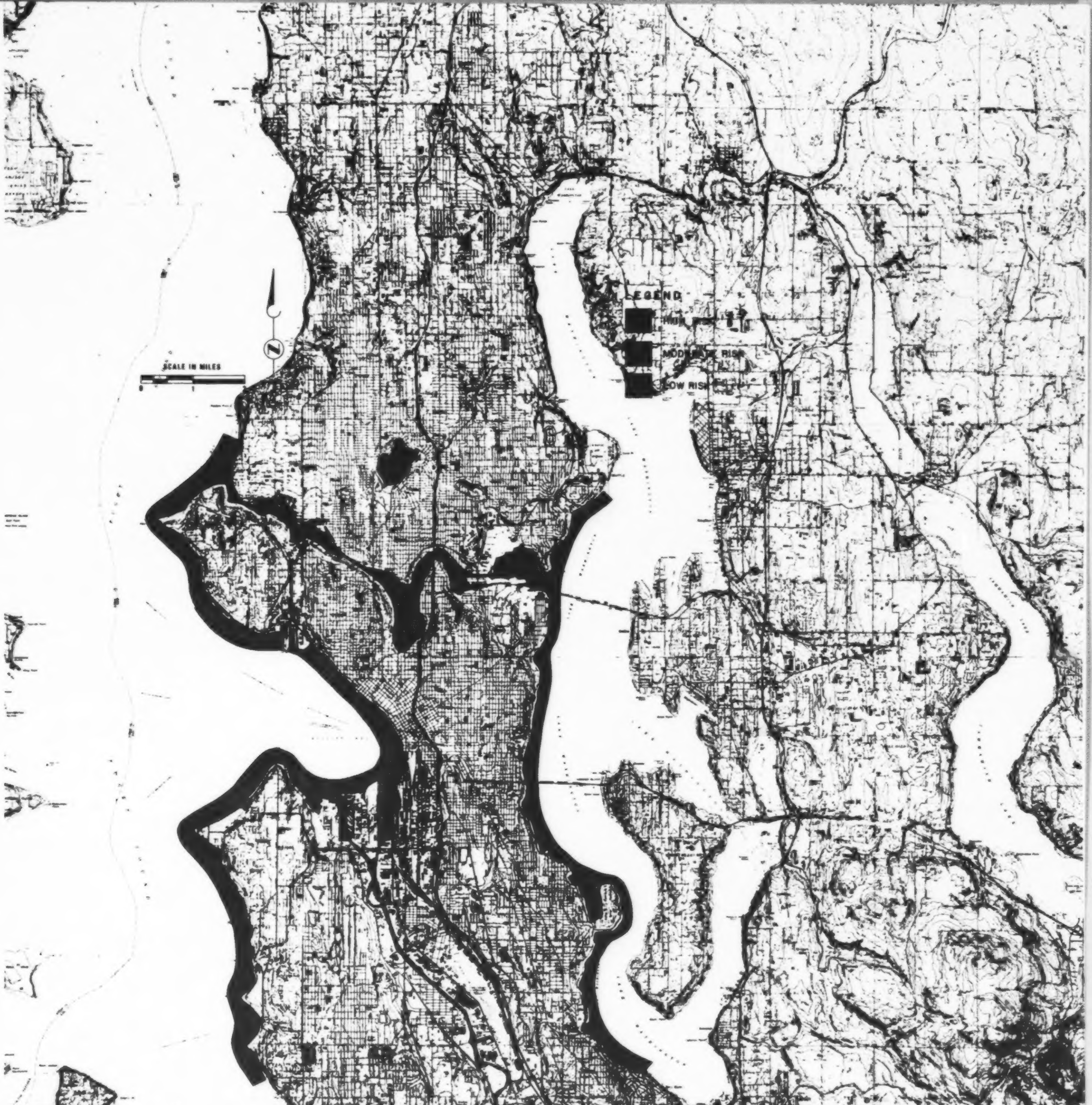

SCALE IN MILES
N
LEGEND
HIGH
MODERATE RISK
LOW RIS

Figure 3-6
Relative Priority in Terms of Pollution Risk
from combined sewer overflows.

location of the treatment plants in the various alternatives and site constraints at West Point. Alki and Carkeek Park. The sludge processing options are affected primarily by the ultimate mode of sludge disposal and re-use. Since all the selected alternatives in the Facility Plan involve continuation of the present disposal method of landfill at Cedar Hills, the process options were not investigated in detail and were limited to the various technical options available in the market for sludge dewatering.

The continuation of the present Metro sludge disposal to Cedar Hills landfill and study of forestry application was selected on a short-term basis while research and planning on sludge management and disposal continues. Continuation of the present practice was recommended in the Facility Plan due to land availability for sludge disposal at existing sites and flexibility. The requirement for large commitments of money and energy to other sludge treatment and disposal methods was also a factor in the Facility Plan recommendation. However, in the interim Metro will continue experimental forestry applications and will experiment with incineration, pyrolysis, agricultural and park use, and land reclamation.

The interim sludge disposal method proposed in the Draft Facility Plan would have little or no effect on the useful life of the Cedar Hills landfill, according to Metro calculations. The useful life of the landfill is projected at about thirty years under current practices where primary sludge contributes only 3 percent of the daily landfill load. If the wastewater facilities include secondary treatment, there would be an increase in the sludge production by a factor of 1.8; this extra load would reduce the useful life of the sanitary landfill by one year. If further physical/chemical treatment were used (including lime and alum), the greatest reduction in the life of the sanitary landfill would be five years.

These figures are based on the assumption that the landfill site could not be re-used. However, if the sludge could be excavated after a few years, the same sludge lagoon could be used indefinitely. There is research underway to determine if this sludge can be adequately dried out in the sludge lagoons. The Cedar Hills landfill site, because of its location in a wet climate, has a negative evaporation potential of 20 inches/year. Although the Cedar Hills site has incorporated dewatering techniques such as sand drainage and seeding, it has not been determined whether the sludge will dry out.

Various other disposal and/or re-use options were considered briefly and to varying degrees in the Facility Plan;

however, they were rejected as immediate measures. These options include ocean dumping, Puget Sound outfall, land reclamation, incineration, pyrolysis with municipal refuse, public or commercial fertilizer, agricultural use, park use and landfill. Reference is made here to the Facility Plan for further information and future plans.

Sludge transportation alternatives were also evaluated and related to opportunities at different regional processing centers. For more detail, the reader is referred to the Draft Facility Plan.

Flow and Waste Reduction Measures

Prior to the development of wastewater management alternatives and sizing of transport and treatment systems for projected future loading requirements, measures for potential flow and waste reduction were investigated. Such measures, if found acceptable and economical, may decrease system operations and maintenance costs, extend the useful life of existing wastewater collection and treatment facilities, and reduce the size and therefore the costs of future facilities. Flow and waste reduction measures include such items as collection system rehabilitation to reduce infiltration and inflow, domestic water conservation, and industrial pretreatment of wastewater. Industrial waste reduction, in both volume and strength, could also reduce loads on present and future facilities and prevent the introduction of some toxic or undesirable pollutants into the wastewater stream where they may disrupt treatment processes or contaminate either the discharged effluent or the waste residuals.

Infiltration/inflow (I/I). Infiltration is water which enters the sewer system from groundwater seepage to defective pipes, pipe joints, connections or manhole wells; inflow is water discharged to the system from roof leaders, yard drains, stormwater runoff and similar sources. Infiltration and inflow add considerably to the volume of the wastewater in a collection system and hence increase the cost of wastewater transportation and treatment. PL 92-500 (Section 201(g)(3) and (4)) requires applicants for treatment works grants to demonstrate that sewer systems tributary to those treatment works are not subject to excessive infiltration/inflow (I/I). Excessive I/I is defined as the quantity of infiltration/inflow which can be economically eliminated from a sewer system by rehabilitation, as determined by a cost-effective analysis that compares the costs of correcting the infiltration/inflow conditions with the total costs for transportation and treatment of the infiltration/inflow.

In compliance with PL 92-500, detailed infiltration analyses were conducted on the collection system in the Metro service area. The results of the analyses showed that the infiltration in the West Point service area was not excessive, except in one component agency collection system. At Richmond Beach, Carkeek Park and Alki, the infiltration again was not found to be excessive; however, some areas at Carkeek Park were close to having excessive I/I.

Inflow analyses were conducted also on the Richmond Beach and Carkeek Park collection systems. By the removal of roof drain connections from the Highland sewer district, a reduction in inflow of one mgd to the Richmond Beach treatment plant would appear to be cost-effective. Reducing inflow at Carkeek Park to the level determined to be cost-effective would reduce peak flows at the treatment plant from 26 mgd to 12.5 mgd. For West Point and Alki the majority of the collection system is combined; therefore combined sewer overflow control measures were adopted to store the peak wet weather flows for discharge to the collection system after the flow rate subsides. For West Point, inflow into all the agencies'systems except the City of Seattle was not excessive; combined sewer overflow studies would determine the cost-effectiveness of inflow control measures. Such measures were employed to a varying degree in the regional alternatives which will be discussed later in this chapter.

Disconnection of drainage hookups to the sewer system can reduce inflow appreciably. The major sources of stormwater connections are catch basins, roof leaders, and yard, basement, and foundation drains. Catch basins in streets have usually been disconnected during Seattle's Forward Thrust sewer separation programs; however, roof, yard and foundation drains are usually left hooked up to sanitary sewers.

Present city ordinances prohibit connection of these drains to sanitary sewers, although connections still occur to combined sewers. No effort to disconnect existing foundation and roof drains from sanitary sewers has been made.

Adoption of measures such as animal control, regular street sweeping and catch basin cleaning as well as control of gasoline additives would reduce stormwater pollutant loadings.

Domestic water conservation. In a combined sewer system where storm flows and infiltration from a high groundwater table constitute a large proportion of annual average flows, the benefits of domestic water conservation are reduced over a system that contains primarily dry weather flow. In Seattle, infiltration to the West Point plant constitutes 30 to 45 percent of the average daily flows of 70 to 90 million gallons per day (mgd), while domestic or nonindustrial flow appears to be about 30 mgd. Since the system is already sized for much higher flows of up to 350 mgd, the domestic flow is not a serious factor in overall system sizing. However, domestic flow may be a factor in the sizing of dry weather facilities (such as dry weather secondary treatment) or in expanding facilities developed to meet only sanitary sewerage requirements in separate collection systems from newly developed areas.

Approaches to domestic water conservation include flow reduction or flow conservation devices, pricing structures, educational programs, and mandatory conservation programs. Such methods or a combination of these can reduce domestic water consumption contributing to the wastewater flows in new dwellings by as much as 50 percent.

The effect of dry weather flow reduction by domestic water saving measures on treatment plant sizing has been estimated by Metro and Metropolitan Engineers.

At West Point, a reduction of 50 percent in domestic flows would decrease the domestic contribution from about 30 to 15 mgd. This reduction of 15 mgd would in turn decrease dry weather flows (70 to 90 mgd) by about 20 percent and wet weather flows (350 mgd) by about 5 percent. Because the system transports substantial volumes of infiltration in dry weather and inflow in wet weather, the result of major domestic water conservation efforts would have only minor impacts on total flows.

The Draft Facility Plan indicates a potential reduction in domestic water flows of 7 to 25 percent, (depending on the extent to which measures are applied), but this would not result in a comparable 7 to 25 percent decrease in wastewater treatment plant size or cost. This is due to the fact that the hydraulic capacity for both transfer and treatment units (for all but those areas sewered within the last decade), is dictated by infiltration and storm flows. Therefore, domestic water conservation would not significantly influence treatment units sized on the basis of peak flow.

Total solids loads reaching the wastewater treatment plant would not change with domestic water conservation. (In fact, the solids concentration in incoming wastewater would increase as flows decrease and solids loads remain constant).

In the secondary treatment process, the aeration or oxidation step for accelerating biological decomposition is based on solids load, so the size of these facilities would not be affected by water conservation. Industrial pretreatment measures could influence this aspect of the design for West Point or the Duwamish plant under Alternative F where industrial contributions are significant.

The second stage of secondary treatment,clarification or settling, is sized on the basis of peak flow rates. Water conservation has the potential to reduce peak flow rates if the sewer system is not subject to infiltration-inflow; however, all of the service areas to the four Puget Sound plants are subject to increased flow in wet weather. Accordingly, as a practical matter, water conservation measures would not change clarifier design recommendations so long as peak flows are governed by wet weather influences. In a tight system where infiltration-inflow is low, some savings in clarifier sizing could result. For example, if 25 percent flow reduction were accomplished at Richmond Beach (the tightest sewer system of the four in question), the two 65-foot diameter secondary clarifiers shown in plant layouts could be reduced to two 54-foot diameter tanks. A savings of approximately $210,000 would be associated with this example,or approximately $30 per home for each of the 7,000 homes in the Richmond Beach service area. The home owner would have to pay for retrofit devices to convert to low water use, which would likely be on the order of $30 per home. Other costs for administering a mandatory conservation program at Richmond Beach would also have to be considered.

Given that Richmond Beach is the area of highest potential effect from domestic water conservation, the relative savings at the other plants would be less. For example, at West Point, the minimum dry weather flow to the plant is 60 mgd, which occurs about 6 AM. It peaks at 110 mgd at 4 PM and drops to 100 mgd from 6 PM to midnight. If it is assumed that 40 mgd is the domestic input and that a 25 percent decrease is possible, the flow could be reduced by 10 mgd. If the design point for maximum flow is 350 mgd the reduction is about 3 percent which would have little impact on the plant. In addition, low flow conditions create problems in the interceptors currently; this reduction would make the situation worse and could require the addition of flushing water during low periods. The benefit would be a small reduction in combined sewer overflow.

In addition to plant siting and effects of water conservation, the relationship to pumping costs and facility staging was addressed by Metropolitan Engineers (1977). Pumping costs would be relatable to total wastewater flows; water conservation measures clearly reduce energy costs and reduce overall operation and maintenance costs.

Water conservation, if strictly followed, could affect sewerage facility staging by delaying incremental expansions for pumping or for elements of treatment facilities (for example clarifiers) where wet weather flow is not the governing factor. Paralleling of the Kenmore interceptor may be delayed beyond the year 2005 if water conservation is strict, provided infiltration/inflow is held to a minimum. It should be mentioned here that although present day sewer construction techniques permit the assumption that infiltration/inflow may be minimized, as a practical matter there are illicit connections (such as yard and roof drains), and house connections often yield infiltration/inflow flows through lawn watering.

Changes in sewage characteristics can also result from water conservation. Recent information from conscious water conservation efforts in California has indicated sewage flow reductions of 20 to 50 percent have been accompanied by waste strength (concentration) increases of 40 to 75 percent.

Although Metro does not have the authority to require flow reduction measures at this time, subsequent action may be possible if considered desirable by people of the area. Among the most promising possibilities is charging residential customers by volume as measured by their water usage rather than the flat fee now charged. Another possibility is that EPA could require mandatory water conservation before funding wastewater facilities, a topic now under consideration by the federal government.

Industrial water use reduction. Since industrial water use, both present and projected, represents only 10 to 20 percent of the total wastewater flow in the Metro service area, any major reduction in the water use will not contribute significantly to the reduction of the wastewater flows. Furthermore, factors restraining industries from excessive water consumption, such as the cost of water to industry and the industrial cost recovery (ICR) system required by PL 92-500, act at the present as possible incentives to industry to maximize its wastewater reduction potential. Further reductions in water use are expected to come as a result of Metro's new industrial surcharge program based in part on flow contributions. At this time it is hard to predict the impact of this measure on the extent of water reduction.

Pretreatment. Treatment to remove pollutants at their source before they enter the sewerage system is known as pretreatment. It can reduce mass pollutant loadings on facilities and prevent the introduction of pollutants which might disrupt the treatment process, contaminate the discharged effluent or affect the waste residuals. Pretreatment efforts are generally focused on large (industrial or commercial) contributors of pollutants such as toxic metals.

Pretreatment requirements are regulated by PL 92-500, as well as state and local laws. The Municipality of Metropolitan Seattle has the responsibility of transporting, treating and disposing of industrial wastes considered acceptable by local, state and federal regulations. Industrial growth in the area served by Metro is encouraged as treatment processes are utilized to achieve maximum acceptance.

Most of the industrial wastes generated in the Seattle area discharge into the Metro sewer system or will be connected in the near future. Of the 425,000 Metro users, only 200 are known to discharge more than 50,000 gallons per day or to discharge toxic materials. The concentration of industries along the Duwamish River, Elliott Bay, Lake Union and the Ship Canal places them in the West Point service area. Therefore, some industrial flows can comprise part of the combined sewer overflows to those water bodies. For more detail on industries, the Draft Facility Plan should be consulted.

To assess the contribution of industries to the pollutant loads and the potential benefit of pretreatment, a rough metal balance was made on the West Point treatment plant influent (Metropolitan Engineers, 1976). Table 3-4 presents the heavy metals contribution of industrial sources, the water supply system and urban runoff. It can be concluded from the table that for cadmium and chromium, industries contribute over one half of the wastewater metals load. Although definitive requirements by the EPA for pretreatment have not been finalized, the merits of pretreatment for specific industries discharging into Metro sewer system can be justified. More stringent pretreatment requirements would reduce the heavy metal loads to the treatment plants and improve the effluent quality discharged into Puget Sound. Sludge quality also would improve, and the potential for its re-use could be enhanced because the possibility for generating adverse impacts on forested land or agricultural application would be reduced.

TABLE 3-4

WEST POINT INFLUENT METALS LOAD BALANCE (LB/DAY)

Element	Water Supply	Industrial Waste	Urban Runoff	Renton Transfer	Total Load	Plant Influent
Cadmium	0.24	4.3	0.61	1.15	6.3	6.5
Lead	1.4	27	49	12.6	90	103
Nickel	0.8	13.2	--	8.0	(22)	56
Copper	39.7	13.6	10.2	68.5	131	205
Zinc	121.5	26	36	50.5	234	420
Chromium	--	45	3.7	10.3	(59)	93

Beneficial Re-use of Reclaimed Water

Section 201(g)(2)(B) of PL 92-500 states that applicants for treatment plant construction grants should satisfactorily demonstrate that the works proposed for grant assistance will take into account and allow to the extent practicable the application of technology at a later date which will provide for the reclaiming or recycling of water or otherwise eliminate the discharge of pollutants. These concepts were evaluated in the Draft Facility Plan, as summarized below.

In order to assess the possibility of reclaimed water re-use in the service area, the potential market sites for re-use and the corresponding water quality and degree of treatment were defined.

At the present, treated effluents from West Point, Alki, Carkeek Park and Richmond Beach are discharged to Puget Sound. Potential beneficial uses of the reclaimed water in the service areas include landscape irrigation of public parks and ground, agricultural irrigation, forest land irrigation, industrial operations, Ship Canal lockage water, and lake rehabilitation.

Agricultural re-use. The application of reclaimed wastewater for agricultural re-use, particularly for irrigation and fertilizer value, was evaluated in the Draft Facility Plan as summarized below.

Water quality requirements for irrigation focus primarily on microbiological and chemical considerations. With the use of reclaimed water, the microbiological quality is of utmost importance, and the requirement may vary depending on the type of crop being irrigated and the intended use of the crop. The chemical composition is also an important factor. The dissolved solids content, heavy metals concentration, cadmium:zinc ratio, and sodium adsorption ratio (SAR) are of interest when considering the land application of wastewater.

Agricultural lands are limited in the Puget Sound region. In the Cedar and Green River basins it has been estimated that about 20,000 acres were cropped in 1968, of which approximately 15 percent were irrigated. Most of the crop lands are located in flood plains and are subject to seasonal high water table. Agricultural irrigation would be costly and difficult to implement. Distribution and storage facilities would be required, together with buffer zones around the irrigated areas, strict operational controls and surface and groundwater quality monitoring. Problems in using reclaimed water on agricultural lands include the following:

- Urban encroachment continues to reduce the area in crops.
- Farms are generally of small size (about 60 acres average).
- Use of pasture land requires a high degree of wastewater disinfection (23 total coliform per 100 ml), and, for food crops, filtration of wastewater is required before application.
- Much of the area is subject to flooding, which could move sediments with high concentrations of heavy metals and phosphorus into surface waters.
- Much of the area would require subsurface drainage systems to eliminate high water table.

Reclaimed wastewater facilities and operational requirements would cost more than irrigation from conventional ground or surface water sources for nearly all lands in the region. Therefore, crop irrigation with wastewater is not justified economically. Irrigation use would not reduce the requirements for secondary treatment with complete disinfection.

Forest lands having suitable soils for irrigation have been identified within a distance of 50 miles from Seattle.

Wastewater irrigation of forest lands might increase timber production, although evidence to date suggests a 10 percent decline in natural seedling growth; undewatered sludge applications to forest stands provide moisture and nutrients for growth as well as added organic matter to improve forest soils. Forest irrigation was investigated under the RIBCO program, and it was found that the annual costs for storage and distribution of wastewater outweighed the value of increased timber production. Undewatered and dewatered sludge applications are subjects of recent Metro research projects and may prove feasible in some areas around Puget Sound. It should be noted that Metro is currently providing the University of Washington with secondary treated effluent from Renton for use in forest irrigation studies conducted in conjunction with the U. S. Army Corps of Engineers.

Industrial re-use. Major industry in the Seattle area is concentrated in the Duwamish valley and presently has a water demand of over 20 mgd. Potential usage and estimated costs to transport effluent to industry were weighed against the present inexpensive, abundant, freshwater supplies already in use. A minimal potential exists for industrial use of reclaimed wastewater, according to the Draft Facility Plan. Considerable recycling and in-house conservation practices by industry are anticipated due to the recent introduction of industrial waste surcharges, an industrial cost recovery program and federal pretreatment regulations. This would further diminish the potential market for renovated water.

Stream flow augmentation. Stream flow augmentation by treated wastewater discharge, although not often recognized as such, is the oldest form of re-use. Currently, all wastewater collected within the area served by the four Puget Sound plants is discharged to marine waters; however, if unsewered areas were served by inland plants, stream discharge and flow augmentation to the Sammamish River and for lake flushing could be considered as effluent re-use modes. High levels of treatment would be required, involving nutrient removal as well as special attention to public health issues. It should be emphasized that the State Department of Ecology has a policy discouraging discharge of treated wastewater in the Lake Washington drainage basin. However, despite the regulatory policy, it must be recognized that currently, during summer months, low influent flows to Lake Washington are exceeded by lake losses due to ground seepage and evaporation, hence the interest in lake discharge from a water resource standpoint. The DOE indicates, however, that treated sewage would not necessarily be considered an improvement over saltwater; even high quality effluents with a large amount of nitrogen or phosphorus will cause substantial algae problems in Lake Washington. Also, as a result of lack of flushing water from the lake, saline Puget Sound waters enter the Ship Canal during lock operation. Analogous to stream flow augmentation, wastewater effluent could be added upstream of the locks to ensure a positive net outflow and prevent the current saline intrusion. Again, the impacts of this effluent on nutrients, bacteria or toxicants would have to be considered along with costs relative to more efficient lockage or more storage on the Cedar River.

Reclamation for other uses. Other potential effluent re-uses include groundwater recharge, direct re-use as municipal water supply and recreational re-use.

The deliberate recharge of treated wastewater to groundwater basins by either surface methods or injection face a number of technical and legal problems. Virus contamination, nitrogen and mineral accumulation, and water extraction rights all have to be considered. For the study area, natural recharge through the large surface water areas of Lake Washington and Lake Sammamish ensure groundwater supplies in excess of extraction requirements, rendering recharge unnecessary.

Reclamation of wastewater for domestic consumption or for body contact recreation represents the most advanced form of re-use and requires more consideration of technical, political and psychological factors. It is unlikely, according to the facilities planning engineers, that these forms of water reclamation would be justifiable in the Seattle metropolitan area, where abundant local sources of high quality water offer greater potential at lower cost. The Seattle area enjoys a wealth of salt and freshwaters; consequently, wastewater re-use for recreational purposes has no real potential.

REGIONAL ALTERNATIVES

Eight alternatives on the regional level are being considered and evaluated by the Draft Facility Plan. These alternatives differ in the degree to which issues such as cost, water quality, site impacts, and compliance with the law are addressed. The regional alternatives consist of one "no-action" alternative, one alternative in line with the present comprehensive plan for the study area, two which emphasize combined sewer overflow abatement with minimal treatment upgrading, and four alternatives which achieve secondary treatment with variations on combined sewer overflow controls, site impacts and re-use options.

The eight alternatives are summarized below and in Figure 3-1. They are described in more detail in subsequent sections of this chapter. Mixtures of component elements could be blended to design hybrid alternatives as described at the end of this section.

Alternative A - No Action

No capital expenditure would be made for expansion, modification or upgrading of treatment plants or construction of new interceptors during the planning period (until 2005). Alternative A is evaluated to meet SEPA "no action" requirements.

Alternative B - Metro Comprehensive Plan
(No Action Pursuant to PL 92-500)

Plant upgrading and transfer interceptor construction would be done according to the Metro Comprehensive Plan. Alternative B is also evaluated as the "no action" alternative pursuant to PL 92-500 and NEPA requirements; therefore, it serves as the baseline for other alternatives in the EIS. Puget Sound plants at West Point, Alki, Carkeek Park, and Richmond Beach would be retained with primary treatment. Improved sludge management and disinfection practices would be provided in Alternative B and all following alternatives. Four new transfer interceptors and improvements to the Alki outfall would be included.

REGIONAL ALTERNATIVES

Eight alternatives on the regional level are being considered and evaluated by the Draft Facility Plan. These alternatives differ in the degree to which issues such as cost, water quality, site impacts, and compliance with the law are addressed. The regional alternatives consist of one "no-action" alternative, one alternative in line with the present comprehensive plan for the study area, two which emphasize combined sewer overflow abatement with minimal treatment upgrading, and four alternatives which achieve secondary treatment with variations on combined sewer overflow controls, site impacts and re-use options.

The eight alternatives are summarized below and in Figure 3-1. They are described in more detail in subsequent sections of this chapter. Mixtures of component elements could be blended to design hybrid alternatives as described at the end of this section.

Alternative A - No Action

No capital expenditure would be made for expansion, modification or upgrading of treatment plants or construction of new interceptors during the planning period (until 2005). Alternative A is evaluated to meet SEPA "no action" requirements.

Alternative B - Metro Comprehensive Plan
(No Action Pursuant to PL 92-500)

Plant upgrading and transfer interceptor construction would be done according to the Metro Comprehensive Plan. Alternative B is also evaluated as the "no action" alternative pursuant to PL 92-500 and NEPA requirements; therefore, it serves as the baseline for other alternatives in the EIS. Puget Sound plants at West Point, Alki, Carkeek Park, and Richmond Beach would be retained with primary treatment. Improved sludge management and disinfection practices would be provided in Alternative B and all following alternatives. Four new transfer interceptors and improvements to the Alki outfall would be included.

Alternative C - Major Combined Sewer Overflow Control

Major portions of combined sewer overflows would be controlled by transfer from fresh to saltwater and/or by upgraded treatment. The existing Puget Sound plants would be upgraded to provide enhanced primary treatment by physical/chemical treatment of solids during the summer. A new wet weather enhanced primary treatment plant would be constructed in the lower Duwamish industrial area, and the Alki plant would be abandoned, both in 1995. Five new transfer interceptors would be built. Nineteen holding tanks would be built to control combined sewer overflows. One new outfall to Elliott Bay would discharge wet weather flows. The Duwamish plant effluent would be treated.

Alternative D - Partial Combined Sewer Overflow Control

Wet weather combined sewer overflows would be reduced to Lake Washington, Lake Union and the West Seattle shoreline and transferred to saltwater. The four Puget Sound plants would be upgraded to enhanced primary treatment with chemical addition during the summer for improved solids removal. Eight holding tanks would be built to control combined sewer overflows. One new outfall to Elliott Bay would discharge wet weather flows. Four new transfer interceptors would be constructed.

Alternative E - Secondary

Secondary treatment would be added to the West Point, Alki and Richmond Beach wastewater treatment plants by 1985. The Carkeek Park plant would provide primary treatment for wet weather flows only beginning in 1985; dry weather flows would be pumped to West Point. The Carkeek Park plant could be abandoned probably in 1995 (depending on City of Seattle sewer separation programs). Five new transfer interceptors would be constructed.

Alternative F - Secondary/Southern Strategy

Secondary treatment would be provided at Richmond Beach and West Point (with a reduced service area). A major new secondary treatment facility would be constructed in the Duwamish industrial area in 1985; the Alki plant would be abandoned at that time. A new outfall off Alki Point would be built for discharging effluent from the Duwamish (and Renton) plants. The Carkeek Park plant would provide primary treatment for wet weather flows only beginning in 1985; dry weather flows would be pumped to West Point. The Carkeek Park plant would be abandoned, probably in 1995 (depending on the City of Seattle sewer separation program). Seven new transfer interceptors would be built to accommodate changes in treatment plant service areas.

Alternative G - Secondary/West Point Phaseout Option

Secondary treatment would be provided at the Alki and Richmond Beach plants. West Point would continue as a primary treatment plant for wet weather flows only, beginning in 1985. A new secondary treatment plant in the Interbay area (Commodore Way or Golf Park sites) would be constructed. The Carkeek Park plant would provide primary treatment for wet weather flows only beginning in 1985; dry weather flows would be pumped to West Point. The Carkeek Park plant would be abandoned, probably by 1995 (depending on the City of Seattle sewer separation program). Six new transfer interceptors would be built to accommodate changes in treatment plant service areas.

Alternative H - Deconsolidation/Reclamation

Secondary treatment would be provided at West Point, Alki, Carkeek Park and Richmond Beach. Areas of growth would be served by new inland plants with local effluent and sludge re-use possible. Advanced waste treatment would be provided at new North and South Lake Sammamish plants. A new secondary plant at Kenmore would discharge treated effluent to Puget Sound through a new outfall off Richmond Beach. Three new transfer interceptors would be built.

Other Alternatives

Various combinations of components from the various regional alternatives could be selected to compose a new alternative, designed to achieve a different blend of objectives on site effects, costs, water quality, legal compliance, or other factors. Some of the new hybrid alternatives which have been suggested as of July 1977 are summarized below:

1. Secondary plus combined sewer overflow control was suggested by several persons attending the May 25, 1977 regional workshop on the Facility Plan and EIS. This type of combination, which suggested no specific sites for secondary treatment, would improve water quality relative to alternatives with only secondary treatment or CSO control. For the comparable CSO reduction in Alternative C, capital costs for secondary alternatives E through H would be approximately $100,000,000 more than respective secondary alternatives.

2. A combination of the West Point Phaseout Option (Alternative G) plus the Southern Strategy (Alternative F) was suggested. This could involve constructing two new treatment plants and (depending on facilities siting) could reduce CSO's. Although not calculated yet, both water quality improvement and costs would appear to increase. Site effects on the new plant sites would occur, but would be balanced by a greater potential for parkland uses at West Point.

3. Another proposed variation includes (1) phase-down of West Point to a wet weather plant only, possibly with enhanced primary but not secondary treatment; and (2) construction of the new Duwamish plant with secondary capability and sufficiently large capacity so that it can handle the dry weather load now carried by West Point, Alki, and Carkeek. West Point would then continue to serve as a wet weather plant, and Alki and Carkeek would be phased out. Dewatered sludge could be phased out. Dewatered sludge could be handled at West Point or facilities could be added at Renton and/or Duwamish to process it. The major advantage of this proposal is that it would permit West Point to phasedown while avoiding the practical problems of building an Interbay plant.

4. Another alternative would be a mixture of A (No Action) and H (Deconsolidation/Reclamation). It is responsive to the comments that a limited future interceptor service alternative might have beneficial impacts and it recognizes the merits of the Kenmore proposal.

This alternative would consist of no plants on Lake Sammamish; growth in that area would use existing Metro interceptors and feed to Kenmore or West Point, or be on permanent septic tanks coupled with management and inspection systems.

In addition, either (1) the Kenmore plant with a pipeline to Puget Sound would be constructed or (2) effluent from north Lake Washington would be routed to the Richmond Beach or Lynnwood plants and more south Snohomish development would be put on permanent septic tanks with management and inspection systems. With money saved from not building the Kenmore plant, it is possible that the Duwamish plant could be built according to revised alternative, described above in item 3.

If Black Diamond wants to be served by Metro, a small decentralized system to serve Black Diamond-Lake Sawyer could be built, eliminating interceptor connections to Renton.

This alternative would create more opportunities for local regulation of growth, but costs have not been calculated. The transfer of treated wastewater flows to saltwater rather than Lake Sammamish would benefit lake water quality relative to it.

5. The Alternatives Selection Task Force of the Citizens Water Quality Advisory Committee (CWQAC) has developed 24 new combinations that combine various features of alternatives. All contain secondary treatment to comply with PL 92-500 requirements. Addition of CSO controls to secondary alternatives (E, F, G, or H) or combinations of secondary alternatives (such as F and G) have been proposed in terms of several options: (1) holding tank CSO controls, (2) retaining Carkeek Park as a wet weather plant with eventual phaseout, (3) constructing a Duwamish wet weather treatment plant. The CWQAC task force also summarized advantages and disadvantages of these new combinations in terms of plant CSO control, legal requirements, potential for effluent re-use, shoreline fill, plant size, financial effects, water quality and other factors. The task force envisions CWQAC narrowing down the alternatives to a smaller number for input into the facilities planning process.

On June 28, 1977, after preliminary task force work, the full committee of CWQAC selected six "hybrid" alternatives which seemed the most appealing for further development. All assume secondary treatment, combined sewer overflow controls, and a Duwamish plant. Other factors important in CWQAC's selection were abandoning the Alki plant, reducing expansion at existing plants, deemphasizing relocation of the West Point plant, deconsolidation and reclamation of sludge and/or effluent. The six hybrid alternatives suggested by CWQAC are as follows: Alternative F-2 (Alternative F, plus wet weather treatment capacity at Duwamish plant and holding tank CSO controls), Alternative F-3 (Alternative F, plus wet weather treatment capacity at Duwamish, holding tank CSO controls, and Carkeek retained as wet weather plant), Alternative H-3 (Alternative H, plus Duwamish wet weather plant, holding tank CSO controls, and conversion of Carkeek to wet weather plant), Alternative F/G-3 (Alternatives F/G, plus wet weather treatment capacity at Duwamish plant, holding tank CSO controls, and retention of Carkeek Park for wet weather treatment), Alternative F/H-2 (Alternatives F/H, plus wet weather capacity for Duwamish plant and holding tank CSO controls) and Alternative F/H-3 (Alternatives F/H, plus wet weather capacity for Duwamish plant, holding tank CSO controls, and retain Carkeek for wet weather).

6. For Alternative F, three alternative plant sites in the Duwamish area were identified by the City of Seattle. Site Number 1 is the Boeing Oxbow parking lot, which is bordered on the east by East Marginal Way, on the west by West Marginal Way and approximately bisected by the 30th Avenue bridge. This site is presently owned by Boeing and is large enough to accommodate a Duwamish treatment plant. Site Number 2 is northwest of Site Number 1, it is bordered by the Duwamish to the east, 96th Street to the south, 15th Avenue South to the west and 91st Street to the north. According to Metro staff, Site Number 2 is too small for the Duwamish plant and is owned by Seattle City Light. Site Number 3, located north of Site Number 2, is bounded to the east by the Duwamish, to the south by Donovan, to the west by 15th Avenue, and to the north by Cloverdale. Site Number 3 is owned by the City, but Metro staff indicate it is too small for the proposed Duwamish treatment plant

Several points on these new potential alternatives are worth mentioning. First, the possible combinations are large, so it may be efficient for those involved in the Facility Plan/EIS process to determine which features of alternatives (such as CSO control to Lake Washington, abandoning Alki, converting West Point or Carkeek Park to a wet weather plant to contain site expansion, or use of Interbay or Duwamish plants) are desirable or undesirable. Then the options can be narrowed down to a manageable number. Second, the new alternatives suggested to date incorporate few if any components that have not been included in one of the eight regional alternatives. Therefore, blending would not mean developing entirely new concepts or components. Third, all suggested recombinations include secondary treatment plus some form of CSO control.

Determinations on hybrid alternatives would be made before the final EIS is complete.

IMPACT ANALYSIS METHOD

The analysis of environmental impacts was based on information on existing conditions (Chapter II) plus details on population, wastewater flow, loads, costs, site requirements, energy consumption, sludge truck traffic, employment and other relevant information. Much of the background material for analyses is available in the Draft Facility Plan.

Impacts of these and other factors are described in the Draft EIS in the remaining portions of Chapter III. Each alternative is described, then followed by a discussion of its impacts to the year 2005. Finally, impacts of all alternatives are summarized.

The analysis evaluates several components of impacts:

(1) Cause - such as combined sewer overflow, change in wastewater flow and loads, plant siting;

(2) Effect - such as changes in water quality or biology, costs, impact on recreation;

(3) Quality - beneficial or adverse;

(4) Magnitude - such as major, minor, significant;

(5) Extent - large or small area;

(6) Duration - long- or short-term;

(7) Reversibility - reversible or irreversible;

(8) Probability - general terms for the likelihood of impact;

(9) Relationship to alternative - direct (primary) or indirect (secondary) impacts.

Measures that could mitigate adverse impacts are presented, followed by a listing of unavoidable adverse impacts.

Impacts are described numerically to the extent possible. Where quantitative information is not available or is uncertain, the impacts are presented in narrative form.

Growth impacts are described in two places, first as they affect water quality under each alternative, and second in a separate section on generated growth impacts.

A numerical matrix was used as part of the impact analysis in the Preliminary Draft EIS. The matrix involved numerical determinations of the degree of impact and significance of impact for each alternative on approximately 150 impact categories. The two numbers were multiplied together, with the products added to give a rating by alternative for the physical environment, the biological environment, the human environment and natural resources/ energy. The totals for each alternative were then compared. It was deleted from the Draft EIS at the request of EPA, DOE, and Metro primarily because of difficulties in quantitatively relating future impacts to uncertainties in existing data and in defining clearly the differences among alternatives. However, it is possible that a revised version of the matrix could be used in the Final EIS.

ALTERNATIVE A
NO ACTION

The description of Alternative A and its projected impacts to the year 2005 are presented in this section.

Description

Alternative A represents the no action alternative in which the existing facilities would continue to operate with no capital improvements or new construction.

The major wastewater facilities contained in Alternative A are illustrated in Figure 1-2. Major features of the alternative are summarized in Table 3-5, including treatment plants, effluent discharges and combined sewer overflows.

The alternative is further described below in terms of service area, treatment plants (location, treatment process, effluent disposal site), combined sewer overflow control, and sludge management. The indirect or secondary effects of the facilities proposed under this alternative on the Renton plant are also described.

Service Area

The service area of Alternative A would be as shown in Figure 3-1. No changes would be made in the service area relative to existing conditions.

Treatment Plants

The wastewater treatment facilities under Alternative A would be as shown in Table 3-5. The West Point, Alki, Carkeek Park and Richmond Beach plants would continue to provide primary treatment; treated wastewater would be discharged through the existing outfalls at each plant.

The West Point treatment plant would treat 104 mgd average, 350 mgd peak flows. This would represent no change over 1975 flows in anticipation of continuing sewerage service to 510,000 people. Some of the remaining 321,000 would locate in the already sewered areas, but plant capacity would not be increased.

TABLE 3-5

ALTERNATIVE A - NO ACTION

SUMMARY

TREATMENT PLANTS

	WEST POINT	ALKI	CARKEEK PARK	RICHMOND BEACH	RENTON*
Process	Primary	Primary	Primary	Primary	Secondary
Flow (mgd) 2005 (average/peak)	104/350 2	10/30	3.5/20	2.5/9	33/96
Disposal	Puget Sound	Puget Sound	Puget Sound	Puget Sound	Duwamish

COMBINED SEWER OVERFLOW (2005)

	FLOW (Million Gallons/Yr)	SOLIDS (Ton/Yr)	BOD (Ton/Yr)
Lake Washington	16	15	4
Lake Sammamish	0	0	0
Portage Bay/Montlake Cut	195	177	48
Lake Union	42	38	10
Ship Canal/Salmon Bay	186	169	46
Elliott Bay	358	325	89
Alki Beach	5	5	1
Duwamish/Green River	251	227	62
TOTAL	1,053	956	260

TREATMENT PLANT DISCHARGES

	FLOW (Million Gallons/Yr)	SOLIDS (Ton/Yr)	BOD (Ton/Yr)
West Point	43,100	10,800	14,400
Alki	3,650	910	1,220
Carkeek Park	1,530	380	510
Richmond Beach	910	230	300
Renton	12,050	750	760
TOTAL	61,240	13,070	17,190

MAJOR NEW TRANSFER FACILITIES

None

*Not included in proposed Facility Plan for Puget Sound plants

The average flow at Alki, Richmond Beach and Carkeek Park would increase to be 10, 2.5 and 3.5 mgd respectively due to increases projected for the sewered population in these service areas. However, no modifications in the plants would be made since the plants were sited to handle a dry weather flow that corresponds to the volume of sewage that would be expected from the 2005 populations.

Combined Sewer Overflow Control

In Alternative A, combined sewer overflows would not change relative to existing conditions. No new facilities for controlling CSO's would be built, but the present in-line storage system would continue to be operated in its present manner.

Sludge Management

The sludge management system for Alternative A would continue as under existing conditions, with West Point functioning as the regional sludge management facility. Anaerobically digested sludge from Carkeek Park and Richmond Beach would be trucked to the Interbay pumping station for further transfer to West Point influent, subsequent settling, anaerobic digestion and dewatering. Digested sludge from Alki would be trucked, undewatered, to the Cedar Hills landfill. Untreated sludge from Renton plus the solids from West Point influent would be anaerobically digested at West Point, dewatered, and trucked to Cedar Hills landfill and the Pack Forest site. Methane gas produced by anaerobic digestion would be used to the extent possible at the West Point, Alki, Carkeek Park and Richmond Beach plants.

Renton

Although the Renton service area and treatment plant are not included in the facilities for Alternative A, the alternative would have secondary or indirect impacts on the Renton plant. Since no action would be taken, Renton capacity would remain at 33 mgd average, 96 mgd peak because no major change would be made in the sewered population within the service area. Secondary air activated sludge treatment would be continued before discharging wastewater to the Duwamish. Sludge from primary and secondary settling facilities would be treated at West Point.

Primary Impacts

The direct impacts of this alternative are described below in terms of geology, soils and topography; air quality and odors; water quality; biology; energy and natural resources; and the human environment. Indirect impacts of this alternative and the effects of Renton discharge are summarized in a later section on secondary impacts.

Geology, Soils and Topography

Because no site modifications are included, the No Action Alternative would have no impact on slopes and soil stability, erosion and deposition, topography and soil profile, or shorelines.

Risk of damage from earthquakes, a function of location and soil properties, would continue. Any potential damage is expected to be minor and of limited extent. Structures on fill, peaty, soft, or loosely consolidated soils would be at greatest risk.

The outfalls would continue to affect the character of the surface of marine sediments which lie in preferred plume positions, by influencing organic content, grain size, and chemistry. Shoreline sediments would continue to be occasionally subject to similar effects associated with effluent on eastside beaches.

Impacts of future sludge disposal practices at the Cedar Hills landfill and the Pack Forest experimental site would continue to be monitored. For Cedar Hills, the useful life is expected to continue for 30 years (approximately to 2007) under projected sludge loadings for this alternative.

Air Quality and Odors

The trucking of sludge from Richmond Beach to West Point and from West Point, Carkeek Park, and Alki to the Cedar Hills landfill would emit approximately 480 grams of hydrocarbons, 3020 grams of carbon monoxide, and 2200 grams of nitrogen oxides per day. Operating personnel traffic to wastewater treatment plants would generate approximately 2460 grams of hydrocarbons, 31,700 grams of carbon monoxide, and 4050 grams of nitrogen oxides per day. The combined emissions would be less than 0.01 of 1% of Seattle's total daily emissions of hydrocarbons, carbon monoxide, and nitrogen oxides. The air pollutants emitted under this alternative would have a negligible, long-term, adverse, reversible impact on the air quality of the Seattle area. Trucking to Pack Forest would involve more vehicle miles of traffic and also pollutants, but the overall contribution to the airshed would be minor.

Because there are no changes in the treatment plants under this alternative, the potential for odor problems at each plant would continue as at present. CSO's and their associated odors would continue as at present in Lake Washington, Portage Bay, Lake Union, the Ship Canal, and Elliott Bay. The potential odor problems associated with this alternative would have a minor, adverse, long-term, reversible impact on the environmental quality of the Seattle area.

Water Quality

Under the No Action Alternative, combined sewer overflows would not be further controlled and would continue at present levels until 2005. Additional sewered population within the Alki, Carkeek Park and Richmond Beach service area would increase wastewater flows and loads from these plants to Puget Sound, but West Point flows and loads would remain as under existing conditions. Principal areas of interest for water quality impacts are Lake Washington, Lake Union/ Ship Canal, Duwamish Estuary and Puget Sound.

Lake Washington. Information available to project future combined sewer overflow (CSO) impacts on Lake Washington is limited. Metro data on present overflow quality is available for one overflow point (Madison Park) during two storms sampled in August 1976. Data, summarized in Table 3-6, indicates certain contaminants such as PCB's, several pesticides, mercury and cadmium exceeded EPA water quality criteria for freshwater life. Based on dye studies, water moves rapidly to shore toward a bathing beach, so public health impacts of water quality are also of interest.

Under Alternative A, combined sewer overflows would continue at their present levels: approximately 16 million gallons per year, carrying 15 tons of suspended solids and 4 tons of biochemical oxygen demand (BOD) (Metropolitan Engineers, 1977). Flows and loads are approximate, since CSO's can vary with rainfall patterns, time since last storm and other factors. Loads of toxicants, nutrients,

TABLE 3-6

SELECTED WATER QUALITY PARAMETERS
LEVELS IN MADISON PARK OVERFLOW, AUGUST 1976
AND WATER QUALITY CRITERIA

Parameter	Levels in Overflow	U.S. EPA WATER QUALITY CRITERIA
Cadmium	<0.004-0.061 mg/l	0.0004 mg/l Salmonids 0.004 other freshwater life
Chromium	0.01-0.04 mg/l	0.3 mg/l
Mercury	0.0005-0.003 mg/l	0.00005 mg/l
Nickel	<0.02-0.07 mg/l	0.1 mg/l
PCBs	0.63 μg/l	0.001 μg/l
Pesticides		
Aldrin/Dieldrin	0.007-0.03 μg/l	0.003 μg/l
DDT/DDE/DDD	0.002-0.53 μg/l	0.001 μg/l
Heptachlor	0.002-0.003 μg/l	0.01 μg/l
Lindane	0.009-0.787 μg/l	0.01 μg/l

Source: Metro Staff; Combined Sewer Overflow Studies,1976;
U.S. EPA Proposed Water Quality Criteria, 1975

microorganisms and other factors have not been calculated due to insufficient information.

The adverse impacts of continued CSO's on water quality of the lake as a whole are expected to be minor, since the flows from 41 CSO points along the western shore of the lake would be small in comparison to the lake volume (6,900,000 million gallons). Impacts would be limited to the western shore, intermittent, and continuing through the planning period. Many changes in water quality (temperature, dissolved oxygen, microorganisms) would be reversible; however, accumulation of toxicants such as PCB's, pesticides, and heavy metals would tend to make these effects irreversible. Temporarily elevated coliform counts from combined sewer overflows moving toward bathing beaches (diluted about 8:1) following storms, would cause regulatory agencies to close beaches for health reasons.

Lake Union/Ship Canal. Information for projecting future impacts of combined sewer overflows to Lake Union/Ship Canal is limited. Of the 32 CSO points along the waterway, one at Roanoke Street (discharging to Lake Union) was sampled in August, 1976 (Metro Staff, 1976). Data shown in Table 3-7 for Roanoke Street indicates several metals and pesticides exceeded EPA criteria for freshwater life. BOD concentrations of 10-29 mg/l and suspended solids concentrations of 48-148 mg/l were measured in the same survey.

According to calculations in the Draft Facility Plan (Metropolitan Engineers, 1977), CSO's to Lake Unon and the Ship Canal/Salmon Bay would continue at current levels under Alternative A. Thus, combined sewer overflows to Lake Union would total 42 million gallons, carrying 38 tons of solids and 10 tons of BOD per year. Similarly, the CSO flow would continue at 186 million gallons to Ship Canal/Salmon Bay per year, with 169 tons of solids and 46 tons of BOD. Figures are approximate since CSO loads and flows are somewhat variable. Furthermore, total discharge of toxic materials has not been calculated.

Effects of overflows would probably be minor in the Ship Canal, which is relatively well flushed. Lake Union, however, has poor circulation and would receive from four major and four minor overflows about 42 million gallons per year. In the absence of data, it is estimated that projected increases would probably have a minor but extensive, adverse impact on water quality.

TABLE 3-7

SELECTED PARAMETERS IN THE ROANOKE STREET OVERFLOW, AUGUST 1975, AND U.S. EPA PROPOSED WATER QUALITY CRITERIA FOR FRESHWATER LIFE

Parameters	Overflow	U.S. EPA 1975 Criteria
Cadmium (Cd)	<0.004-0.031 mg/l	0.0004 Salmonids 0.004 mg/l others
Chromium (Cr)	<0.01-0.06	0.3 mg/l
Mercury (Hg)	0.0004-0.0018	0.00005 mg/l
Nickel (Ni)	<0.02-0.02 mg/l	0.1 mg/l
PCBs	0.59 μg/l	0.001 μg/l
Pesticides		
Aldrin/Dieldrin	0.001-0.03 μg/l	0.003 μg/l
DDT/DDE/DDD	0.003-0.118 μg/l	0.001 μg/l
Heptachlor	0.001-0.009 μg/l	0.01 μg/l
Lindane	0.02-0.04 μg/l	0.01 μg/l

Source: Metro Staff; Combined Sewer Overflow Studies,1976;
U. S. EPA Proposed Water Quality Criteria,1975

Other freshwaters. The No Action Alternative is not projected to directly affect water quality in the Cedar, Sammamish or Green Rivers or in Lake Sammamish.

Duwamish estuary. The direct effects on water quality due to combined sewer overflows are described in this section; indirect impacts from Renton treatment plant effluent are described in a later section. Relative to Renton effluent, the effects of CSO's are expected to be minor since they would contribute a total of approximately 251 million gallons per year to the Duwamish, compared to an annual Renton flow of 12,050 million gallons in 2005.

Information on which to project water quality effects from CSO's to the Duwamish is limited. During August 1976, surveys of the Hanford overflow to the Duwamish indicated mercury, PCB's and two pesticides in the overflow exceeded EPA criteria for freshwater life, as shown in Table 3-8. Quality is expected to be variable depending on storm characteristics. According to the facilities planning engineers, annual CSO flows to the Duwamish in 2005 (as in 1975) would be 251 million gallons, carrying 227 tons of suspended solids and 62 tons of biochemical oxygen demand. Annual toxicant loads have not been calculated because only limited information exists.

Unlike Renton effluent, CSO's would contain completely untreated wastes eight times higher in oil, grease and other constituents. They would also continue to contribute plugs of material with major rains. The highly probable effects on nearshore areas from toxicants and heavy metals could be significant, because of the volume discharged, but localized in nature for identifiable impacts. However, pollutants from the Duwamish are known to move toward West Point beaches so toxicants could have more far reaching adverse irreversible impacts. Impacts would be long-term since CSO's are intermittent but continuing. Inputs of greater volume and concentration from industrial sources and Renton are felt to be more significant overall, however, for water quality in the Duwamish.

Puget Sound. Water quality in Puget Sound is expected to be influenced by treatment plant discharges and some combined sewer overflows to Elliott Bay and off Alki Beach. Flows from West Point and CSO's would continue at 1975 levels, but wastewater discharged off Alki, Carkeek Park and Richmond Beach would increase by 21, 33 and 52 percent relative to existing conditions. Overall, the effect on Puget Sound from Metro wastewater facilities would continue

TABLE 3-8

HANFORD OVERFLOW TO THE DUWAMISH
SELECTED PARAMETERS IN OVERFLOW, AUGUST 1976, COMPARED TO USEPA CRITERIA, 1975

Parameter	Overflow	Criteria
Cadmium (Cd)	<0.004-0.078 mg/l	0.0004 mg/l (Salmonids) 0.004 mg/l (other FW) 0.005 mg/l (marine)
Chromium (Cr)	<.01-.07 mg/l	0.3 mg/l
Mercury (Hg)	0.0006-0.0014 mg/l	0.00005 mg/l (FW) 0.0001 mg/l (marine)
Nickel (Ni)	<0.2-0.11 mg/l	0.1 mg/l
PCBs	2.51 μg/l	0.001 μg/l
Pesticides		
Aldrin/Dieldrin	0.02, 0.003 μg/l	0.003 μg/l
DDT/DDD/DDE	0.01 (DDE only)	0.001

Source: Metro Staff; Combined Sewer Overflows Study, 1976
U.S. EPA Proposed Water Quality Criteria, 1975

essentially at present levels.

The No Action Alternative would have no effect on the temperature or salinity of Puget Sound. Nturients discharged from West Point have apparently resulted in a 15 to 20% increase in 1, 2, 3, 5, and 10 year primary production extremes within a mile north and south of the treatment plant and an over-enrichment of waters at West Point beaches reflected in intertidal plants and animals. As municipal and industrial flows and combined sewer overflows are expected to increase in the future, an additional nutrient load would be placed on the Sound which would increase the magnitude of observed effects. The adverse impact on the Sound would probably be moderate, because of the size of the flows; felt throughout the waters off West Point; of long duration, because the discharge will continue through the planning period; and reversible for parameters other than metals and toxicants.

Suspended solids discharged by CSO's along Alki Beach and Elliott Bay would continue at present levels, causing adverse impacts judged to be minor, because the effects are incremental. Impacts would also be extensive, because a large area is affected, and of long duration, primarily because of induced biological stresses. Additional solids loads could deposit within pores of sand, changing the substrate chemistry and the structure of the environment for benthic fauna. Offshore and nearshore, the solids load should cause no measurable difference from the present system.

From the standpoint of microbiology and related public health concerns, the adverse impacts of continued CSO's and nearshore discharge from the Alki outfall would be significant, as violations of state fecal coliform standards for commercial shellfish waters would continue. Impacts would be extensive, as the entire shoreline in the Metro area appears to be affected, and long-term, as the occurrence of problems is intermittent but continuing. Effects would be reversible, as pathogens are generally inactivated after a certain period. Intertidal and nearshore subtidal clams would probably be unsafe at times due to bacterial or viral contamination from wastewater treatment plants or CSO discharges.

The effects of heavy metals input on Puget Sound, which would continue and increase slightly under Alternative A, are not well understood. Although the Puget Sound Interim Studies have made a concerted effort at assessing existing impacts, the issue is complex and additional studies are needed for more complete understanding of the relative heavy metals loading from various sources (Metro wastewater plants, other municipal facilities, industrial discharge, non-point sources of water pollution including CSO's, vessels and aerial fallout) as well as the fates of the metals in Puget Sound. Nearshore and offshore waters are presently high in lead and cadmium, but these levels are not attributable to Metro from existing data. Estimates of inputs for copper, lead and zinc, shown in Table 2-7 previously, suggest that the West Point facility and other municipal plants are sources of minor or equal importance with other man-caused sources. The net effect by 2005 of increasing heavy metals loads from Metro outfalls and CSO's under Alternative A on intertidal nearshore and offshore waters is unknown.

Toxicants and PCB's are not thoroughly understood in the existing discharge situation, which would continue under Alternative A. It is possible that toxicants in Metro discharges are adversely affecting beaches at present, but the levels of toxic constituents in Metro's wastewater and in receiving waters have not been fully determined. The Metro plants receive both domestic and industrial wastes, but detailed measurements of toxicants have yet to be made. Impacts at some beaches may be more likely due to CSO's or outflows from the industrialized Duwamish area (including Renton effluent), which flow from the Duwamish River estuary into Elliott Bay and move toward West Point. Contributions of toxicants to nearshore and offshore waters would probably be less, primarily because CSO's and the Duwamish discharge would be likely to reach them only in small amounts.

For PCB's, which could accumulate in water bodies, the Toxic Substances Act of October 1976 prohibits their manufacture, sale, or use, other than in a totally enclosed environment, after January 1, 1978. All manufacture of PCB's is prohibited as of January 1, 1979 and all distribution as of July 1 of that year. Although PCB's are now in wide use, it is expected that as of 1978-1979 their presence in overflows and treatment plant effluents in the study area will begin to decline. However, future growth in commerical and residential areas may produce greater inputs of other toxicants to Puget Sound through sewage effluent and CSO's. As many toxicants and PCB's do not degrade readily, such chemicals already in local waters will be available for biotic uptake and concentration for a long time. For the facilities planning period, their presence is considered to be long-term and essentially irreversible.

Dissolved oxygen in Puget Sound is expected to be affected to a minor extent around outfalls under Alternative A, as it is under present conditions. Water quality profiles of the waters around the four Metro outfalls were made at established stations on one day in January, 1975 and two days in August 1974 as part of the Puget Sound Interim Studies (Environmental Quality Analysts, November 1974 and May 1975). The results, shown in Tables 3-9 and 3-10, are shown as dissolved oxygen (DOE) and turbidity (% light transmittance) measurements at standardized depth increments. As the oxygen figures are interpolated from actual sampling depths and rounded-off to the nearest tenth mg/l, the investigators estimate the accuracy of the data to be 0.1 mg/l. At the stations closest to the West Point outfall (1/8 mile radius) sampled in summer (W001-W006) the DO at depths below 130-150 feet appears to be decreased by 0.1 to 0.6 mg/l more than at other stations near the outfall and elsewhere. Assuming the West Point effluent has a BOD of 100 mg/l, after an initial dilution of 140:1 at the diffuser, the effluent could exert an oxygen demand on surrounding waters of the magnitude of the effect observed.

The low DO values observed at depths to 300 feet, however, are well below the observed lowest depth of the rising effluent plume (150 feet), based on depression in light transmittance or tubidity. In addition, stations both near and far (W145, W146) from the outfall tended to show lower DO values in intermediate and deep waters at slack tide, with higher DO values observed at all stations at flood or ebb tides. It has been suggested by the investigators (J. Robertson, personal communication, 1977) that the observed pattern in DO values are the result of localized changes in the vertical distribution of deep water masses, probably as the result of tidal currents. The deep waters of Puget Sound enter the central basin from Admiralty Inlet and age as they flow south at depth, gaining in nutrients and losing oxygen, such that these waters may have a characteristic DO of less that 6 mg/l. Deep water is entrained upwards by an effluent plume, which creates a localized upwelling condition. From the above information, the writers conclude that the lower DO values in the water column below 165 feet are due to variations in the distribution of central basin deep waters.

At the same time, the vertical extent of the West Point effluent plume was most clearly evident at one station (W001, summer) at slack water, as a 50% increase in turbidity and perhaps a 0.5 mg/l drop in DO between 65 and 150 feet (Table 3-9). Other stations equally close to the outfall at which the effluent field was discernible at similar depths by turbidity changes showed no or only very small concomitant decreases in DO of 0.1 to 0.3 mg/l (W002-W006). As 0.1 mg/l is the stated limit of accuracy of the data, and changes in DO with depth of 0.2 to 0.4 mg/l occur at the same depths at stations far from the outfall, the observed differences

TABLE 3-9

Water Quality Profile Data West Point 8/27/74 – 8/28/74

STATION	#141[a]	#135[a]	#136[a]	#132[a]	#130[a]	#130	#001	#002	#003	#004	#005	#006	#131	#132	#133	#134	#135	#136	#137	#138	#139	#140	#141	#142	#143	#144	#145	#146	#147	#148	#150[a]
TIME	1119	1137	1153	1212	1220	855	905	915	925	930	954	1005	1200	1150	730	747	1132	1100	619	835	710	805	830	1059	1310	1333	823	921	1029	1045	1145
DISSOLVED OXYGEN (MG/L)																															
0	8.0	7.3	7.0	7.3	6.7	7.9	7.2	8.5	8.0	8.0	7.1	7.5	7.7	7.1	9.9	10.6	7.4	7.4	7.2	7.5	11.1	10.5	8.1	7.5	8.7	13.64	10.4	10.6	8.1	8.0	7.4
5	8.3	7.0	7.5	6.8	6.3	8.0	7.5	8.5	8.1	7.8	7.9	7.9	7.6	7.7	9.3	8.6	7.4	7.7	7.4	7.8	9.6	9.7	7.8	8.0	9.1	10.80	9.5	9.6	8.5	8.1	7.8
10	8.1	7.5	7.4	6.7	7.0	7.4	7.6	7.5	7.2	7.3	7.3	7.6	7.2	7.7	8.5	7.5	7.2	7.2	7.1	7.6	8.3	8.2	7.2	7.9	7.6	7.88	8.1	8.1	8.0	7.5	7.5
15	7.5	7.3	7.2	6.8	7.3	7.2	7.6	6.9	6.8	6.8	7.1	7.3	6.9	7.7	7.6	7.0	7.1	7.1	7.0	7.0	7.9	7.3	6.9	7.5	7.0	7.32	7.4	7.2	7.4	7.0	7.2
20	7.3	7.2	6.9	6.7	7.2	7.1	7.1	6.6	6.3	6.7	6.9	7.0	6.9	7.3	7.0	6.8	7.0		6.9	6.7	7.3	7.1	6.7		6.8	7.17	7.0	6.8	7.3	6.8	7.2
25	7.2	7.1	6.6	6.7	7.1	6.7	6.6	6.7	6.3	6.5	6.7	6.7	6.8	7.1	6.9	6.6	6.9		6.8	6.6	7.2	7.0	6.7		6.7	6.78	6.6	6.7	7.1	6.7	7.1
30	7.1	7.0	6.7	6.6	6.9	6.4	6.3	5.5	6.3	6.5	6.8	6.7	6.7	7.0	6.7	6.6	6.8		6.7	6.4	7.2	7.0	6.5		6.5	6.71	6.4	6.7	7.1	6.5	7.0
35	7.0	7.0	6.6	6.4	6.6	6.4	6.2	6.4	6.1	6.4	6.7	6.8	6.6	6.9	6.7	6.6	6.7		6.6	6.2	7.1	6.9	6.6		6.4	6.65	6.4	6.6	7.2	6.5	6.7
40	7.0	7.0	6.5	6.2	6.6	6.4	6.2	6.3	6.2	6.4	6.6	6.7	6.3	6.7	6.6	6.5	6.7		6.5	6.1	6.9	6.8	6.5		6.4	6.60	6.4	6.5	7.1	6.6	6.5
45	6.9	6.9	6.4	6.3	6.7	6.3	6.2	6.3	6.2	6.2	6.5	6.6	6.2	6.6	6.5	6.4	6.6		6.4	6.0	6.8	6.8	6.4		6.3	6.60	6.3	6.4	7.0		6.3
50	6.8	6.9	6.5	6.2	6.3	6.4	6.2	6.1	6.0	6.1	6.4	6.5	6.1	6.4	6.3	6.3	6.5			6.1	6.5	6.5	6.3		6.3	6.39	6.2	6.4	6.8		6.3
55	6.7	6.8	6.5	6.2	6.6	6.3	6.2	6.1	5.8	5.9	6.3	6.6	6.1	6.3	6.3	6.2	6.4			6.1	6.5	6.4	6.1		6.3	6.22	6.2	6.3	6.7		6.2
60	6.4	6.7	6.4	6.2	6.5	6.2	6.1	6.1	6.0	6.0	6.2	6.5	6.0	6.2	6.3	6.2	6.4			6.2	6.6	6.4	6.0		6.3	6.18	6.2	6.2	6.5		6.2
65	6.4	6.6	6.4	6.2	6.5	6.1	6.1	6.0	5.9	6.0	6.1	6.2	5.8	6.2	6.3	6.2	6.3			6.1	6.4	6.2	6.0		6.3	6.20	6.2	6.2	6.4		6.2
70	6.4	6.5	6.3	6.1	6.4	6.1	6.1	5.9	6.0	5.9	6.1	6.2	5.9	6.2	6.2	6.2	6.2			6.0	6.5	6.4	6.0		6.2	6.18	6.1	6.1	6.4		6.2
75	6.4	6.5	6.3	6.2	6.4	6.1		5.9	5.9	5.9	6.0	6.2	6.0	6.2	6.2	6.1	6.2			6.0	6.4	6.2	6.0			6.28	6.1	6.1	6.3		6.2
80	6.4	6.4	6.2	6.2	6.1			5.9	5.9	5.9	6.0	6.1	6.0	6.2	6.1	6.1	6.2			6.0	6.4	6.2	6.0			6.23	5.9	6.0	6.2		6.1
85	6.4	6.4	6.2	6.1	6.0			5.9	6.0	5.9	5.9	6.0		6.2	6.2	6.1	6.1			6.0	6.3	6.2	6.0			6.17	6.1	6.0	6.2		6.1
90	6.4	6.3	6.0	6.0	6.1			5.8	5.9	5.9	5.8			6.2	6.1	6.0	6.1			6.1	6.2	6.1	6.1			6.20	6.0	6.1	6.1		6.0
95	6.4	6.3	6.0	6.0	6.2			5.8		5.9	5.8					6.0	6.1			6.1	6.3	6.1	6.1			6.23	6.0	6.1	6.1		6.0
HYDROGEN ION CONCENTRATION (PH)																															
0	8.10	8.05	8.10	8.11	8.24	8.23	8.13	8.23	8.22	8.24	8.18	8.52	8.21	8.28	8.45	8.50	8.10	8.24	8.14	8.11	8.47	8.43	8.14	8.30	8.31	8.67	8.49	8.59	8.20	8.28	8.12
5	8.17	8.03	8.06	8.06	8.10	8.17	8.14	8.19	8.14	8.15	8.15	8.49	8.20	8.28	8.28	8.21	8.11	8.21	8.15	8.13	8.20	8.23	8.11	8.30	8.21	8.24	8.28	8.38	8.22	8.26	8.14
10	8.10	8.03	8.05	8.03	8.14	8.13	8.16	8.13	8.11	8.10	8.12	8.43	8.18	8.27	8.21	8.13	8.10	8.20	8.17	8.10	8.15	8.15	8.11	8.27	8.10	8.18	8.19	8.28	8.18	8.23	8.12
15	8.10	8.02	8.06	8.04	8.13	8.12	8.14	8.09	8.09	8.08	8.11	8.40	8.17	8.24	8.14	8.10	8.10	8.16	8.18	8.09	8.11	8.11	8.10	8.22	8.10	8.17	8.15	8.23	8.15	8.19	8.10
20	8.10	8.03	8.10	8.05	8.13	8.13	8.10	8.09	8.09	8.08	8.10	8.36	8.16	8.21	8.14	8.10	8.10		8.19	8.07	8.10	8.10	8.10		8.09	8.15	8.12	8.20	8.15	8.17	8.11
25	8.16	8.03	8.05	8.05	8.12	8.11	8.06	8.09	8.09	8.09	8.10	8.33	8.15	8.20	8.13	8.09	8.10		8.18	8.07	8.09	8.10	8.10		8.09	8.14	8.11	8.18	8.15	8.15	8.10
30	8.16	8.04	8.02	8.05	8.11	8.10	8.05	8.08	8.08	8.09	8.09	8.31	8.14	8.19	8.12	8.09	8.09		8.18	8.07	8.10	8.09	8.10		8.09	8.15	8.11	8.17	8.15	8.15	8.10
35	8.10	8.03	8.03	8.07	8.09	8.10	8.07	8.08	8.08	8.09	8.09	8.29	8.13	8.19	8.12	8.09	8.10		8.18	8.07	8.10	8.10	8.10		8.09	8.14	8.11	8.17	8.16	8.14	8.08
40	8.10	8.03	8.05	8.07	8.12	8.11	8.08	8.09	8.08	8.09	8.10	8.27	8.12	8.18	8.12	8.09	8.08		8.18	8.05	8.09	8.10	8.10		8.10	8.14	8.10	8.16	8.16	8.08	8.08
45	8.10	8.04	8.06	8.09	8.12	8.11	8.08	8.09	8.08	8.08	8.10	8.25	8.12	8.16	8.12	8.09	8.08		8.22	8.06	8.09	8.10	8.10		8.10	8.13	8.09	8.17	8.15		8.08
50	8.16	8.04	8.06	8.06	8.11	8.10	8.09	8.08	8.08	8.08	8.09	8.24	8.12	8.15	8.11	8.09	8.08			8.06	8.09	8.10	8.11		8.10	8.13	8.09	8.16	8.15		8.08
55	8.14	8.04	8.03	8.07	8.10	8.11	8.09	8.08	8.08	8.08	8.08	8.23	8.11	8.16	8.12	8.09	8.08			8.06	8.09	8.09	8.11		8.10	8.13	8.09	8.15	8.14		8.08
60	8.14	8.02	8.04	8.08	8.10	8.10	8.09	8.08	8.08	8.08	8.08	8.22	8.10	8.14	8.11	8.09	8.08			8.06	8.09	8.09	8.10		8.11	8.14	8.10	8.15	8.13		8.08
65	8.14	8.02	8.05	8.09	8.09	8.11	8.09	8.09	8.08	8.08	8.09	8.22	8.10	8.14	8.12	8.09	8.08			8.06	8.08	8.10	8.09		8.12	8.14	8.09	8.15	8.13		8.09
70	8.15	8.02	8.06	8.10	8.11	8.11	8.11	8.09	8.08	8.09	8.09	8.21	8.11	8.15	8.12	8.09	8.08			8.08	8.08	8.09	8.10		8.14	8.14	8.09	8.14	8.13		8.09
75	8.14	8.03	8.06	8.10	8.11	8.01		8.09	8.08	8.09	8.09	8.20	8.11	8.15	8.11	8.10	8.09			8.07	8.08	8.09	8.10			8.14	8.09	8.14	8.13		8.09
80	8.15	8.02	8.05	8.09	8.12			8.09	8.09	8.09	8.10	8.20	8.06	8.14	8.11	8.10	8.09			8.07	8.08	8.08	8.10			8.14	8.09	8.14	8.13		8.09
85	8.15	8.02	8.04	8.09	8.13			8.09	8.09	8.10	8.09	8.21		8.14	8.11	8.09	8.09			8.07	8.08	8.08	8.10			8.14	8.09	8.13	8.13		8.09
90	8.16	8.02	8.04	8.11	8.12			8.10	8.09	8.10	8.09			8.15	8.11	8.09	8.11			8.07	8.08	8.08	8.09			8.14	8.09	8.13	8.13		8.09
95	8.16	8.02	8.05	8.11	8.12			8.10		8.10	8.09					8.09	8.09			8.07	8.08	8.08	8.09			8.13	8.09	8.13	8.13		8.09
LIGHT TRANSMITTANCE (%)																															
0	30	49	47	49	50	41	47	29		26	38	42	49	51	18	8	47	45	50	48	10	8	36	37	35	3	16	18	45	26	47
5	49	54	54	55	46	52	46	46		46	50	47	53	49	34	44	53	52	53	49	45	39	54	41	44	45	39	40	45	52	47
10	52	54	55	58	54	56	44	54		55	56	52	58	49	49	56	55	56	53	53	54	53	60	47	55	55	50	53	56	56	52
15	54	56	56	58	57	59	52	57		59	57	55	58	49	57	57	55	17	54	57	56	57	60	46	59	57	53	57	57	66	54
20	58	57	56	57	58	61	56	59		61	60	58	59	52	60	59	57		56	59	57	57	57		60	58	56	58	56	67	55
25	57	59	55	58	60	58	28	60		61	62	60	60	54	59	61	60		55	57	56	56	55		58	57	56	56	57	57	56
30	56	61	57	58	61	53	28	51		62	62	60	60	56	60	60	62		55	58	56	55	56		57	56	54	55	56	61	56
35	55	60	56	60	59	50	34	49		61	62	59	58	56	61	60	61		51	58	59	55	59		58	59	53	56	56	62	55
40	56	56	56	59	58	45	37	51		60	62	58	57	57	58	59	58		49	46	57	59	59		58	59	54	57	57	58	52
45	57	60	56	59	56	49	49	52		54	61	58	57	56	57	58	56		47	50	56	57	59		56	58	53	55	60		51
50	61	58	56	57	58	49	50	54		52	53	56	54	55	56	56	46			52	56	56	58		55	54	51	56	61		53
55	56	52	58	58	56	49	49	52		53	48	52	53	55	56	56	47			54	55	55	56		55	55	50	55	58		54
60	54	46	57	58	58	49	47	50		54	53	49	48	55	55	55	47			54	53	54	55		54	56	50	54	58		54
65	54	56	53	58	56	48	44	50		52	54	49	43	54	52	55	45			54	51	53	51		50	57	48	52	57		54
70	53	53	51	55	56	46	43	49		52	53	47	42	55	49	55	44			53	48	51	50		43	57	47	50	56		53
75	53	52	50	55	57	24		46		51	51	46	38	55	49	52	44			51	49	49	50			57	46	49	53		53
80	51	49	56	56	56			45		51	50	46	31	54	49	51	44			51	48	48	50			56	45	47	54		53
85	51	47	45	58	54			43		50	48	45		54	48	48	46			49	48	47	49			54	45	45	54		53
90	51	47	42	54	53			43		49	46			52	46	47	46			48	47	47	48			54	45	44	54		53
95	51	47	42	54	53			43		49	46					47	46			48	47	47	48			54	45	43	54		53

[a] Omitted in the average presented in discussion because of duplication

Source: Environmental Quality Analysts, "Report on Study of Wastewater Discharge Areas at the Richmond Beach, Carkeek Park, West Point, Alki Point Submarine Outfalls." Report to Metro, November 1974.

TABLE 3-10

Water Quality Profile Data West Point – January 22, 1975 (cont.)

STATION	W129	W130	W001	W002	W003	W004	W005	W006	W131	W132	W133	W134	W135	W136	W137	W138	W139	W140	W141	W142	W143	W144	W145	W146	W147	W148
TIME	1111	1059	1140	1155	1349	1400	1417	1427	1221	1336	1032	1502	1448	1441	813	921	1009	1517	1552	1648	835	855	947	1533	1615	1636
DISSOLVED OXYGEN (MG/L)																										
0	[a]	[a]	[a]	10.67	10.55	10.67	10.91	10.66	10.10	10.72	[a]	10.70	10.61	10.52	[a]	[a]	[a]	10.28	10.89	10.84	[a]	[a]	[a]	10.57	10.42	10.50
5				11.75	10.46	10.90	11.08	10.73	11.85	10.69		10.89	10.79	10.78				10.56	10.82	10.85				10.60	10.46	10.44
10				10.00	9.53	9.53	9.96	9.97	12.55	9.65		9.56	9.84	9.76				9.59	9.49	10.85				9.74	9.71	9.66
15				8.91	9.31	8.91	9.72	9.44	11.54	9.21		9.05	9.21	9.18				9.23	9.15					9.17	9.23	9.36
20				8.72	9.03	8.84	9.00	9.37	10.00	9.04		8.84	8.97	8.93				8.09	9.09					9.00	8.94	9.22
25				8.55	8.92	8.83	8.84	9.20	9.17	8.97		8.72	8.83	8.78				9.02	8.96					8.96	8.81	9.18
30				8.49	8.90	8.80	8.78	8.98	8.92	8.88		8.63	8.79	8.78				9.01	8.99					8.90	8.74	9.14
35				8.51	8.97	8.83	8.78	8.91	8.74	8.81		8.58	8.83					8.97	8.94					8.77	8.65	9.06
40				8.55	8.90	8.79	8.82	8.86	8.58	8.78		8.62	8.75					8.93	8.85					8.69	8.69	
45				8.47	8.88	8.67	8.77		8.55	8.72		8.61	8.70					8.90	8.81					8.65	8.71	
50				8.43	8.82	8.45	8.73		8.52	8.60		8.57	8.61					8.87	8.62						8.63	
55				8.38	8.78	8.47	8.71		8.47	8.54		8.54	8.51					8.74	8.62						8.54	
60				8.43	8.71	8.35	8.65		8.41	8.60		8.53	8.60					8.70	8.54						8.52	
65				8.49	8.76	8.49	8.76		8.49	8.59		8.62	8.68					8.65	8.51						8.49	
70				8.58	8.80	8.42	8.77		8.30	8.53		8.65	8.65					8.71	8.67						8.42	
75				8.59	8.89	8.60	8.78		8.38	8.52		8.63	8.67					8.78	8.68						8.46	
80				8.59	9.07	8.74	8.75		8.41	8.52		8.58	8.69					8.81	8.69						8.50	
85				8.53	9.00	8.68	8.74		8.41	8.51		8.68	8.66					8.82	8.77						8.44	
90				8.61	9.11	8.58	8.78			8.54		8.74	8.61					8.80	8.78						8.20	
95					9.11		8.79					8.76	8.54						8.72							
HYDROGEN ION CONCENTRATION (PH)																										
0	7.74	7.74	7.74	7.72	7.79	7.79	7.81	7.76	7.69	7.76	7.75	7.78	7.79	7.75	7.75	7.76	7.74	7.77	7.79	7.74	7.74	7.74	7.72	7.77	7.79	7.77
5	7.72	7.72	7.72	7.71	7.75	7.76	7.77	7.75	7.69	7.75	7.72	7.75	7.75	7.74	7.73	7.73	7.74	7.75	7.75	7.72	7.72	7.74	7.72	7.75	7.75	7.75
10	7.71	7.71	7.71	7.70	7.74	7.74	7.74	7.74	7.69	7.74	7.70	7.73	7.74	7.73	7.71	7.71	7.72	7.73	7.74	7.76	7.71	7.73	7.72	7.73	7.74	7.75
15	7.70	7.71	7.70	7.70	7.74	7.74	7.74	7.74	7.69	7.74	7.70	7.72	7.72	7.73	7.71	7.71	7.71	7.72	7.72		7.71	7.72	7.71	7.72	7.73	7.73
20	7.70	7.70	7.70	7.68	7.72	7.72	7.72	7.72	7.68	7.73	7.70	7.70	7.71	7.71	7.71	7.71	7.72	7.70	7.71		7.71	7.72	7.70	7.71	7.71	7.72
25	7.69	7.69	7.69	7.68	7.71	7.71	7.71	7.71	7.67	7.72	7.70	7.70	7.70	7.70	7.71	7.71	7.71	7.70	7.71		7.71	7.72	7.70	7.70	7.71	7.71
30	7.69	7.69	7.68	7.68	7.71	7.71	7.71	7.70	7.67	7.71	7.69	7.70	7.70	7.70	7.71	7.71	7.71	7.70	7.70		7.71	7.72	7.71	7.70	7.70	7.71
35	7.69	7.69	7.69	7.68	7.71	7.71	7.71	7.70	7.67	7.71	7.69	7.70	7.70		7.71	7.71	7.71	7.69	7.70		7.71	7.72	7.71	7.70	7.70	7.71
40	7.69	7.69	7.69	7.68	7.71	7.70	7.71	7.70	7.67	7.71	7.69	7.70	7.70		7.71	7.71	7.70	7.69	7.70		7.71	7.71	7.70	7.70	7.70	
45	7.69	7.69	7.69	7.68	7.71	7.70	7.71		7.67	7.71	7.70	7.69	7.70		7.71	7.71	7.70	7.69	7.70		7.71	7.71	7.70	7.69	7.70	
50	7.69	7.69	7.69	7.68	7.71	7.71	7.71		7.67	7.71	7.70	7.69	7.70		7.71	7.71	7.70	7.69	7.70		7.71	7.71	7.70		7.70	
55	7.69	7.69	7.69	7.69	7.71	7.71	7.71		7.67	7.71	7.70	7.69	7.70		7.72	7.71	7.70	7.69	7.69		7.71	7.71	7.70		7.70	
60	7.70	7.70	7.70	7.69	7.71	7.71	7.71		7.67	7.71	7.70	7.70	7.70		7.72	7.71	7.70	7.69	7.69		7.71	7.72	7.71		7.70	
65	7.70	7.70	7.70	7.69	7.71	7.71	7.71		7.67	7.71	7.70	7.70	7.70		7.72	7.71	7.70	7.69	7.70		7.71	7.72	7.71		7.70	
70			7.70	7.70	7.72	7.71	7.71		7.67	7.71	7.70	7.70	7.70		7.72	7.71	7.70	7.69	7.70		7.71	7.72	7.72		7.69	
75			7.71	7.70	7.72	7.72	7.71		7.67	7.71	7.70	7.70	7.70		7.72	7.72	7.70	7.70	7.70			7.73	7.71		7.70	
80			7.71	7.70	7.73	7.72	7.72		7.68	7.71	7.70	7.70	7.70			7.72	7.70	7.70	7.70			7.73	7.72		7.70	
85				7.70	7.73	7.72	7.72		7.68	7.72	7.70	7.70	7.70			7.72	7.70	7.70	7.70			7.73	7.72		7.70	
90				7.70	7.73	7.72	7.72			7.72	7.70	7.71	7.71			7.72	7.71	7.70	7.70			7.73	7.71		7.70	
95					7.73		7.72				7.70	7.71	7.71			7.72	7.71		7.71			7.73	7.71			
LIGHT TRANSMITTANCE (%)																										
0	0	1	2	0	4	2	13	0	0	0	9	6	6	0	16	5	6	7	8	6	10	6	3	9	9	0
5	21	22	24	27	36	32	23	10	28	31	24	26	25	15	28	29	16	26	23	26	35	18	8	28	28	21
10	46	44	47	47	45	47	45	20	46	48	42	46	45	41	47	46	36	45	45	46	49	38	35	46	40	38
15	47	43	46	46	47	50	47	22	49	48	47	48	46	49	48	48	45	50	47		51	49	48	50	47	42
20	44	43	41	42	50	51	49	34	50	47	49	50	48	52	48	49	48	52	47		51	51	50	51	51	41
25	43	43	41	41	51	51	51	51	50	49	50	51	52	51	50	50	49	53	51		50	53	51	52	51	47
30	45	43	44	43	51	52	53	53	51	51	48	54	53	51	54	50	49	55	52		51	53	51	53	52	43
35	53	45	53	51	52	53	54	53	53	49	50	55	54		54	51	52	56	56		54	53	53	55	52	39
40	55	49	55	55	53	54	54	50	52	50	53	55	55		54	52	54	55	58		55	56	56	55	53	
45	55	55	54	55	55	56	53		52	52	54	54	56		53	53	55	55	59		56	56	57	54	53	
50	54	55	54	54	52	55	53		54	53	55	56	57		53	55	56	56	58		55	56	57		56	
55	55	54	55	55	56	56	55		55	54	57	57	55		53	57	57	57	58		56	60	57		58	
60	54	55	54	54	55	56	55		54	54	57	56	56		53	59	56	58	59		54	60	58		58	
65	56	55	53	53	56	57	55		55	54	58	56	55		50	59	56	58	58		54	60	59		57	
70			50	50	53	55	55		55	54	57	56	56		49	58	56	57	55		51	60	55		56	
75			49	50	51	52	53		54	54	57	57	56		46	55	57	56	56			60	58		57	
80			49	58	52	51	53		[illegible]	55	56	55	57			55	56	57	57			59	57		56	
85				58	52	52	53		[illegible]	57	56	54	57			15	57	57	53			54	56		58	
90				49	52	[illegible]	52			60	52	54	56				57	57	54			59	58		54	
95					52		[illegible]				[illegible]	53	55				57		54			59	57			

[a] Malfunction of Dissolved Oxygen Sensor

Source: Environmental Quality Analysts, "Winter Studies of Wastewater Discharge Areas at the Carkeek Park and West Point Submarine Outfalls." PSIS Report to Metro, May 1975.

at these stations are not considered by the writers to be positively attributable to the effluent plume. In addition, the Sound is variable in time as well as in space, and the available data represent two to three days sampling.

In summary, the available Puget Sound Interim Studies water quality data of existing conditions suggest that the West Point effluent plume may affect DO by as much as 0.5 mg/l in a limited area around the outfall and over limited depths for the duration of a slack tide (about two hours, four times in 24 hours). Since West Point wastewater flows and BOD loads would be the same in 2005 under Alternative A as they are presently, this minor effect would be expected to continue. Decreases in DO at depth at slack tide are considered to be due to mixing or entrainment of deep waters having a characteristically low DO concentration.

Future DO, expected to be similar to present levels, has been compared to water quality criteria to determine possible significance of localized changes. Average minimum DO in central Sound is 5.4 mg/l at 165 feet and 330 feet; it is 6.6 mg/l at the surface (0 feet) (Duxbury, 1976). Marine water criteria for DO recommended by the National Technical Advisory Committee (NTAC, 1968) were a minimum of 5 mg/l for coastal waters and minimum of 4 mg/l in estuaries except where natural conditions cause further depressed levels. As central basin waters meet these criteria, the variations in DO observed are judged not to have a measurable effect on aquatic organisms.

Groundwater. Alternative A is not expected to affect groundwater, since the effluent from all of the Metro treatment plants, except Renton, would be discharged into Puget Sound and is incapable of infiltrating groundwater. No direct impacts on groundwater users, shown in Figure 3-7, are expected.

Flood hazard. No flood hazards are expected for Alternative A, as all sites are above the 100 year flood level.

Biology

The impacts of this alternative on terrestrial habitats, shoreline habitats, Puget Sound, the Duwamish estuary, and commercial and sport fisheries are described below. Since wastewater treatment plant discharges and combined sewer overflows would continue approximately under existing condi-

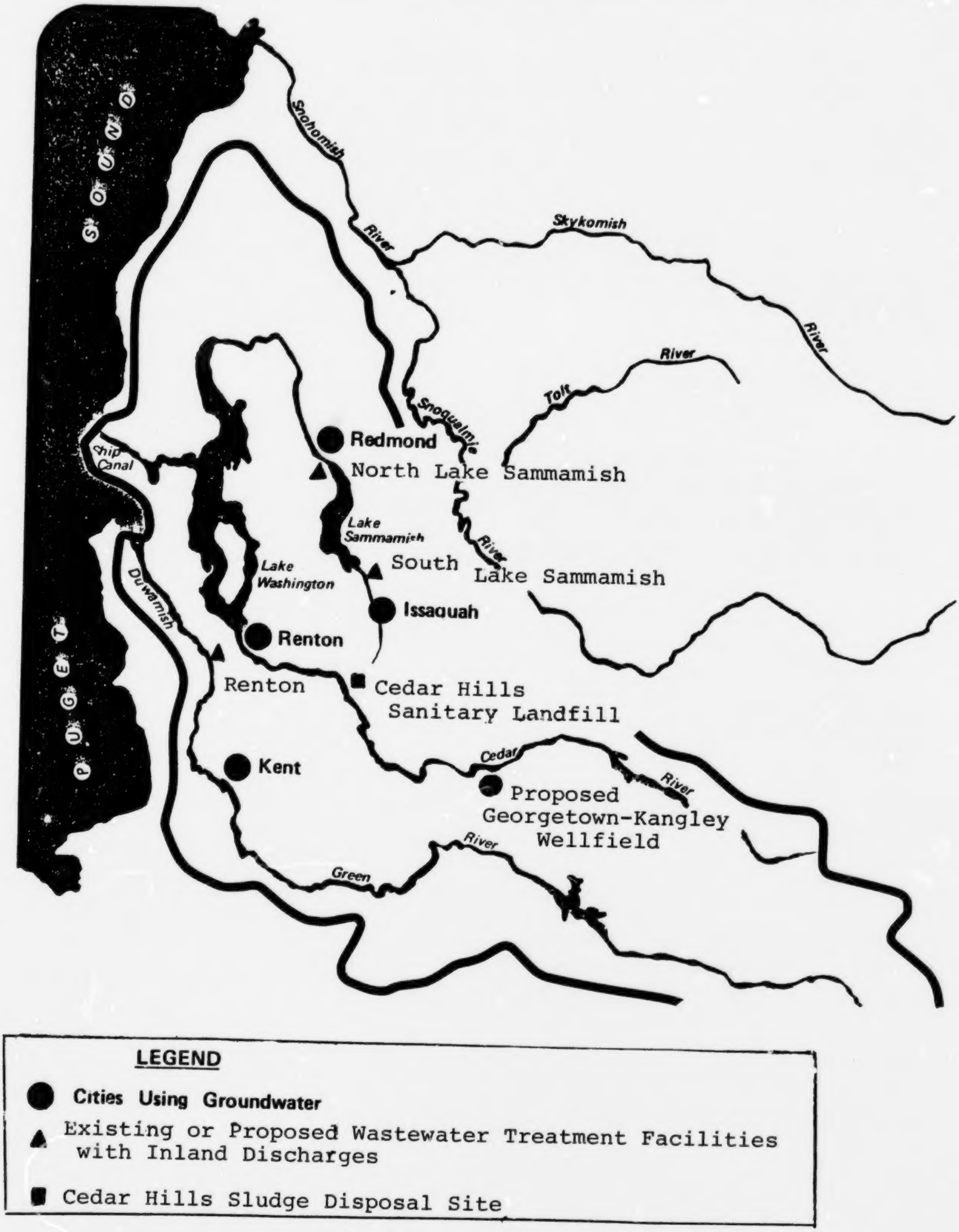

PUGET SOUND
Snohomish River
Skykomish River
Tolt River
Snoqualmie River
Ship Canal
Redmond
North Lake Sammamish
Lake Sammamish
South Lake Sammamish
Issaquah
Lake Washington
Renton
Duwamish
Renton
Cedar Hills Sanitary Landfill
Kent
Cedar River
Proposed Georgetown-Kangley Wellfield
Green River
LEGEND
● Cities Using Groundwater
▲ Existing or Proposed Wastewater Treatment Facilities with Inland Discharges
■ Cedar Hills Sludge Disposal Site

Figure 3-7 Groundwater Impact Potential

tions, the impacts on biota would continue at present levels.

Terrestrial habitats. The No Action Alternative is expected to have no direct impact on terrestrial habitats, such as urban, nonurban, forest and meadow lowland, as no construction is involved.

Shoreline habitats. Since combined sewer overflows under Alternative A would continue at present levels, impacts would continue as under existing conditions.

Freshwater marshes in the study area occur in limited areas along the southwestern shore of Lake Washington, in the Ship Canal, Union Bay and Portage Bay. All marshes except perhaps that at South Andrews Bay are subject to direct combined sewer overflows of various magnitudes, approximately as shown in Table 3-11.

While most individual overflows are relatively small in terms of annual volumes, they are frequent and numerous. In addition, these flows empty into inlets and bays with limited-to-poor mixing and dilution. Based on very limited sampling data (Metro Staff, 1976), overflows contain pesticides, PCB's and metals, in addition to microorganisms, solids and BOD. As CSO's are intermittent but continuing events, their effect on sensitive marshland fishes, birds and other life could be moderate-to-major, adverse, and irreversible in the long run.

Marshland habitats are sensitive and exposed to unknown but probably moderate intermittent and recurring stresses; they may accumulate metals, pathogens, and toxicants in biota which could have long-term detrimental effects on their behavior, physiology and reproduction. Effects on salmon spawning areas result from siltation of nests or from direct toxicity to the eggs and newly-hatched fish.

There is a small saltwater marsh in the study area on Kellogg Island in the Duwamish estuary. A moderate sized overflow point occurs just upstream of the island, but the potential impact has not been investigated.

The intertidal. Future impacts on the intertidal zone would be similar to existing conditions regarding wastewater discharges and combined sewer overflows. Based on the Puget Sound Interim Studies, effluent diluted 250:1 reaches areas occupied by intertidal and nearshore species. The frequency and distribution of this event have not been determined.

TABLE 3-11

COMBINED SEWER OVERFLOWS EMPTYING INTO MARSHLANDS

Overflow	Receiving Water	Volume (mil/gal/yr)
038	Lake Washington	3.1 Westmore Slough
039	Lake Washington	3.1 Westmore Slough
040	Lake Washington	3.1 Lakewood Bay
041	Lake Washington	3.1 Lakewood Bay
042	Lake Washington	3.1 Lakewood Bay
044	Lake Washington	3.1 North Brighton Beach
047	Lake Washington	3.1 Ranier Slough/ Atlantic City Pk
176	Lake Washington	3.1 Ranier Slough/ Atlantic City Pk
171	Lake Washington	3.1 Ranier Slough/ Atlantic City Pk
W041	Duwamish Estuary	2.4 Kellogg Island
018	Union Bay	3.6
021	Union Bay	3.2
139	Portage Bay	Negligible
138	Portage Bay	Negligible
140	Portage Bay	Negligible

Source: McGreevy 1973; Metropolitan Engineers 1977

Changes in the intertidal flora at West Point possibly attributable to effluent nutrients have been described in Chapter II of this report. Based on current patterns in central Puget Sound, as delineated by the physical model, similar effects very likely occur regularly at Alki due to effluent coming up on eastside beaches. Onshore water movement also occurs at Carkeek and Richmond Beach during part of the tidal cycle. Septic tank seepage on the north side of West Point and south of Perkins Lane at Magnolia Bluff may contribute further pollutants to the intertidal in the form of nitrates and pathogens. No measurable effects have been found on the intertidal fauna, except increased limpet growth at West Point. The continuation of this effect under Alternative A is judged to be adverse, of minor magnitude, limited in extent to certain beaches, but of long duration.

Combined sewer overflows in the central Puget Sound intertidal occur at 16 points (excluding Elliott Bay). Major overflows are 002 at the West Point treatment plant, W027 at Denny Way, and A004 at Alki. West Seattle beaches receive a total of approximately 5 million gallons annually and Elliott Bay 358 million gallons (Metropolitan Engineers, 1977). Limited sampling of biota at the Denny Way overflow (Metro Staff, 1976) indicated a highly disturbed situation reflected in low diversity and abundance of organisms. The Denny Way overflow itself met water quality criteria for receiving waters (EPA, 1975) for all parameters except mercury: 0.0006 to 0.0016 mg/l versus a criterion of 0.00005 mg/l. Copper and zinc were generally two to three times higher in biota at Denny Way as in sediments. Mercury was not measured at Denny Way and metals levels in biota at other overflow points were not examined.

As overflows generally contain metals and toxicants which do not degrade and are bioconcentrated, the continued overflows to Puget Sound may possibly have minor-to-moderate adverse long-term effects, limited to certain intertidal areas and generally irreversible, as metals and toxicants do not degrade. Some evidence of this possibility was indicated in the Puget Sound Interim Studies, in which levels of trace metals in intertidal biota at outfall and background areas were examined (Schell et al., 1977). Mercury in mussels and lead in all organisms examined (a brown alga, a green alga, mussels and clams) were higher at all outfall areas than at background areas (Point No Point, Blake Island). Other trace heavy metals which were higher at Metro outfall areas than at background areas were cobalt in clams, zinc in clams and mussels, copper in clams, chromium, selenium, and cerium in mussels. The U.S. Food and Drug Administration mercury standards for shellfish (0.5 ppm) and the Canadian Food and Drug Directorate lead level of 2 ppm net weight were not exceeded in any sample. Standards for other metals have not been set.

Eelgrass beds which occur near Carkeek and at Alki, could continue to be subject to effluents brought up on the beach by tidal currents; also subject to combined sewer overflows. While eelgrass beds are highly productive, and have a unique assemblage of plants and animals, including the larvae of a number of fishes and curstaceans, they tend to be in organic-rich sediments which may be anaerobic just below the surface. Therefore, nutrients, BOD and suspended solids from any source would probably affect them but little. Contaminants such as metals, toxicants or pesticides could, however, be irreversibly incorporated into organisms which become food for juvenile commercial herring, flatfish, young salmon, or waterfowl. The effect is presently unknown but judged to be adverse, probably minor, limited in extent to certain areas and long-term.

Intertidal hardshell clams and subtidal geoducks occur at Richmond Beach in small numbers, south of Carkeek, on the beach south of West Point, at Alki, West Seattle beaches, and at Lincoln Park. State standards for fecal coliforms in shellfish waters have been exceeded at all sites sampled in the study area. Whether the coliforms are due to treatment plant effluents, to sewer overflows or to septic tank seepage has not been determined. Shellfish are not monitored for coliforms in the study area at present. With no action, it is probable that bacterial standards will continue to be exceeded.

Puget Sound. The intertidal, nearshore subtidal, and offshore bottom, free-swimming and planktonic organisms in the study area would continue to be subject to effects of combined sewer overflows, treatment plant effluents, runoff, septic tank seepage, boat wastes, dredge spoil dumps, and other pollutant sources.

Because phytoplankton productivity is subject to effects of naturally varying chemical and physical parameters, it is almost impossible to detect whether treatment plant effluent nutrients affect the variation in algal population size and growth stages in time and space. The only significant longitudinal variation attributed to the West Point outfall is a 15-20% increase in the 1, 2, 3, 5, and 10 year extreme values for productivity at stations within a mile of the outfall. As flows will continue, the continued effect is judged to be adverse, moderate, reversible, limited in extent and of long duration for phytoplankton. No effect on zooplankton has been determined, perhaps due to sampling problems. In the absence of any data, the effect is judged to be unknown.

Metals in effluent could be affecting and continue to influence plankton. Metals in plankton near outfall areas compared to background areas (Schell et al., 1977) showed zinc and coppor significantly higher in plankton at outfall areas than at the control station. Furthermore, the filter feeding zooplankton take in particles of the size on which metals adsorb.

The distribution of some nearshore and offshore benthic organisms (foraminifera, worms, clams, snails) appears to be correlated with typical plume positions for West Point and Carkeek Park effluents, for which data are available, especially along the 50 foot contour. Studies on Alki and Richmond Beach areas have not been performed. The existing and continuing effect is considered to be adverse, moderate, limited in extent, long-term as flows continue, and reversible for nearshore and offshore areas.

Nearshore free-swimming (nektonic) forms (juvenile salmon, herring, and other commercial fishes that frequent the outfall pipe, kelp, or eelgrass areas) could be occasionally exposed to levels of chlorine and perhaps to other constituents at higher than "safe" levels in effluent. Localized effects of effluents in nearshore areas could affect herring populations directly or through their zooplankton prey and thus affect salmon and other organisms which feed heavily on herring in open waters (Miller et al., 1976).

The measured change in fish species composition under recent conditions at West Point, discussed in Chapter II, may reflect effluent-caused changes in benthic prey species and/or toxicants. The cause of the slightly elevated incidence of tumors in flatfish at West Point has not been identified, however. The overall effect is judged to be adverse, major, but limited in extent, of long duration and probably reversible.

While no data are available, it is possible that offshore nektonic organisms may also continue to be occasionally affected by chlorine, pathogens or toxicants if they swim into or through effluent, or if they feed in nearshore areas at night. For marine organisms, a concentration of 0.02 mg/l for 100 minutes is a recommended criterion (Brungs, 1976; Mattice & Zittel, 1977). As peaks of total residual chlorine at the diffuser of 0.02 and higher are common, it seems possible that nektonic organisms congregating at the outfall could be exposed to higher than "safe" levels of chlorine during slack water periods. The potential effect on these organisms is considered to be adverse, minor, limited in extent, of short duration and reversible.

Among the factors contributing to the present concern for potential and environmental impact of chlorination is the formation of halogenated organic compounds, specifically haloforms, in chlorinated effluents. The principal concerns about these compounds as they relate to fish or shellfish residue is that the incorporation of a halogen (chlorine, bromine, iodine, fluorine) into an organic molecule increases its attraction to fats in tissue which usually results in increased toxicity and bioaccumulation. There is a growing sentiment that alternate forms of disinfection to chlorination be emphasized to protect auqatic life. Recent studies (Marine Research, 1976; R. K. Kawaratani, personal communication) have shown that haloforms occur in approximately the same concentrations after disinfection of power station cooling water (saltwaters) with any of chlorine, bromine, ozone, or hydrogen peroxide.

Commercial and sport fisheries. The commercial and sport fisheries that could be affected by continued treatment plant discharges and combined sewer overflows include: salmon (spawning and rearing areas in Lake Washington, runs up the Duwamish and Ship Canal, sport fishing at Harbor Island and Elliott Bay and commercial fishing south of Alki), herring (commercial fishing from north Alki to Harbor Island), steelhead (runs up the Ship Canal and the Duwamish), and shrimp (fished in Elliott Bay to Harbor Island and in Shilshole Bay at the mouth of the Ship Canal). The Ship Canal and lower Duwamish, crucial for the migration of juvenile salmonids, have a high potential for stress on or contamination of these species. The magnitude of the actual present and future effects is unknown, but could be substantial. The abnormal occurrence of salmon at the south end of Lake Union is an example. The overall effect is considered to be highly probable, adverse, moderate, reversible, extensive and of long duration.

The Duwamish estuary. The biota of the Duwamish (which includes anadromous fishes discussed above) are and would continue to be affected by CSO's and Renton treatment plant secondary effluent (discussed in later section), as well as by industrial inputs and runoff. Metro area treated wastewater discharge and combined sewer overflows would continue at existing levels.

Phytoplankton communities would be affected by freshwater (effluent and CSO) flow in the estuary, which determines salinity distribution and to a lesser extent nutrients (which appear not to be limiting). Blooms occur in summer when the temperature is high and freshwater flows are low. Present and future discharges to the Duwamish are not believed to be increasing productivity in the lower Duwamish where blooms occur. The impact at present appears to be small, major CSO's to the Duwamish not withstanding, but data are incomplete. CSO's occur less often in summer, the time of plankton blooms. Information on zooplankton is too sparse to determine effects. It is known, however, that they ingest particles of the size on which heavy metals adsorb. The potential effect is considered to be adverse, minor, extensive, of short duration, and reversible.

The benthic organisms in the Duwamish (predominantly worms) reflect somewhat stressed conditions, including low dissolved oxygen, in summer. The impact on the benthic habitat in the Duwamish to date has been adverse, major, extensive and long-term. Low DO in the lower Duwamish could affect salmonids by delaying migration or generally weakening the fish. The potential effect is considered to be adverse, major, extensive (in the Duwamish), short-term and reversible.

The observed effect on other resident fishes in the Duwamish of primary interest is a high incidence of disease and parasitism. PCB's, which have been implicated in fin erosion, are high in the Duwamish. PCB's were high in the Hanford sewer overflow sampled, however, so it is likely that a portion of the PCB input is from this type of source. The overall effect of Duwamish conditions on resident fishes is considered to continue as negative, major, extensive, and long-term. The effect of PCB's, pesticides and metals is felt to be irreversible, even though their use will be discontinued shortly, since they are not readily biodegradable.

Waterfowl found along the Duwamish, including Kellogg Island where there is a small saltwater marsh, are near an overflow (W041) discharging about 2.4 mil gal/yr. It is not clear whether or not the overflow waters reach the marsh or what future effects would be.

A clearer, more immediate danger to the island is from development, which could certainly eliminate the marsh habitat. Poor water quality could affect the birds' prey species as well. If the latter were concentrating toxicants, the birds could be affected over a long period. The effect on waterfowl of CSO's is unknown but considered to be potential, moderate, adverse, limited, and short-term for parameters other than metals and toxicants.

Freshwater environments. These habitats for a variety of organisms, including sport and commercial fishes, would be affected in the future by combined sewer overflows to the same degree as at present.

1. Lake Washington. A number of combined sewer overflows discharge into salmon spawning areas. Nevertheless, the lake is still in the process of changing from a eutrophic to a meso-eutrophic or better state. Existing effects of CSO's on biota, examined at one point only (Metro Staff, 1976), indicated effects were limited but striking - no macrosopic organisms were found anywhere near the outfall. If it is assumed that this is typical, the effect of continued CSO's on nearshore areas is judged to be highly probable, adverse, limited to the western shore of the lake, and long-term. The impacts of metals, toxicants and nutrients in the overflows are judged to be irreversible as these tend to be recycled in the lake. Effects on offshore lake biota from CSO's are considered to be minor as CSO's tend to move along shore, rather than into open waters.

2. Lake Union/Ship Canal. In general, the biota are those characteristically tolerant of somewhat degraded water quality. The impacts of CSO's on this water are not well understood. Samples from Roanoke Street outfall showed no visible life anywhere near the outfall or the effluent plume. Assuming this effect is typical of the 35 overflows (approximately 200 mil gal/yr) along the Lake Union/Ship Canal, the present and future effects are potentially major on limited areas near the outfalls. Inputs other than CSO's may predominate overall water quality, however, so CSC's are judged to have moderate but extensive and long-term effects overall.

3. Other freshwaters. No impacts from CSO's are expected for Lake Sammamish, Sammamish River, Cedar River or Green River.

Rare or endangered species and critical habitats. This alternative would not affect endangered species since there are none recorded from the study area. Critical habitats, which include salmon spawning and rearing areas, fish migration routes, waterfowl resting areas, and lake shallows, have been discussed in previous sections.

Energy and Natural Resources

Energy and natural resources consumption are summarized in Table 3-12 (based on the Draft Facility Plan).

Energy. Alternative A, a net of approximately 24 million equivalent kwh/year of energy would be consumed in 2005 by the Puget Sound plants. Included in this would be approximately 25 million kwh/year of electrical energy purchased. This is equivalent to the amount of electrical energy 1250 households would consume per year, and constitutes approximately 0.13% of the projected electrical energy consumption of Seattle in 2005 (Appendix E).

Table 3-12 shows the breakdown of total energy consumption on a plant-by-plant basis. The greatest energy expenditure would be for purchasing electricity. Chemicals account for about 15-25 percent of energy consumption, and sludge trucking for less than 5 percent. In the anaerobic digestion of sludge, there is a net production of energy because of methane formation. Under current practice, however, about half of this methane is flared off.

The impact of the energy consumption would be adverse, moderate in magnitude, long-term, irreversible, and definite.

Chemicals. Chlorine consumption would be 2440 tons for the Puget Sound plants: 40 at Richmond Beach, 75 at Carkeek Park, 2150 at West Point, 175 at Alki. West Point would also use 65 tons per year of polymers to aid in the coagulation of sludge.

The impact of chemical usage would be adverse, minor, long-term, irreversible, and definite. The supply of chlorine and polymer is highly reliable.

Human Environment

Alternative A has negative impacts in some categories evaluated as "human environment" factors. A large number of the categories, however, have negligible impacts including Snohomish County plan/zoning, transportation patterns/systems; housing availability, population distribution, local tax base, shoreline use, cultural patterns, and waterfowl hunting.

Land use. Since Alternative A involves no construction, there would be no change in land use at the existing treatment plant sites. Building permits would be unnecessary, and no permit would be required under the Shorelines Manage-

TABLE 3-12

ENERGY CONSUMPTION FOR ALTERNATIVE A

	PLANT				
	Richmond Beach	Carkeek Park	West Point	Alki	Total
Onsite Energy					
Purchased electricity (kwh x 10^6/yr)	0.63	0.97	21.31	2.35	25.26
Produced by digestion (kwh x 10^6/yr)	(0.32)	(0.48)	(16.44)	(0.85)	(18.09)
Consumed by digestion (kwh x 10^6/yr)	0.13	0.19	6.58	0.34	7.24
Offsite Energy					
Chemicals (kwh x 10^6/yr)	0.14	0.25	7.36	0.59	8.34
Sludge Trucking (kwh x 10^6/yr)	0.03	0.03	1.42	0.11	1.59
TOTAL	0.61	0.96	20.23	2.54	24.34

ment Act.

Agency goals. Alternative A, because it includes no construction, does not fulfill the King County Utilities Development policy of "installing trunk utility lines in advance or at the time of development", or its policy that "where pollution conditions now exist, all possible steps should be taken to correct such conditions." This alternative does not alleviate the frequent odor problem at Alki, which (in addition to affecting the Alki residents directly) conflicts with the PSCOG goal of maintaining the natural beauty and liveability of the region. These impacts are adverse, major, long-term, reversible, and definite.

Employment. There would be no construction employment under this alternative, since there would be no construction. Operation and management employment would remain at current levels: 66 employees at the Puget Sound facilities plus other related Metro staff.

Costs. Under Alternative A there would be no capital cost because no new facilties would be constructed. The operation and maintenance costs (excluding Renton) would be $5,170,000 per year (1976 dollars), as shown in Table 3-13 (Metropolitan Engineers, 1977).

The estimated average monthly user charge per equivalent connection for the next 20 years would be $5.25 per month, indicated in Table 3-14 (based on the Draft Facility Plan). The average increase of $1.70 per month over present rates would be due to inflation in operating costs.

Impact of cost would be adverse, minor, long-term, irreversible and definite.

Social, recreational and cultural. Alternative A has a negative impact on regional values and attitudes and recreation.

Alternative A would not fulfill the goal of 54-64 percent of the people interviewed, who indicated a preference for secondary treatment. For more information, please see Chapter II of this document.

Continued combined sewer overflows and dispersed primary effluents could affect recreational opportunities at shellfishing sites. At public beaches, bacteria levels exceeding

TABLE 3-13

Cost Estimate for Facility Plan Alternatives[a]
Capital Costs (in $ million ENR-CCI-2600)

	A	B	C	D	E	F	G	H
Puget Sound Plants[1]	None	81.9	250.8[b]	106.8	212.8	286.5[b]	361.8[c]	307.7[d]
Renton STP[1]*	None	106.1	195.2	195.2	157.2	191.5	157.2	94.3
Total	None	188	446	302	370	478	519	402

[a] In 1976 dollars

[b] Includes Duwamish plant

[c] Includes Interbay plant

[d] Includes construction of Kenmore, North Lake Sammamish, and South Lake Sammamish plants.

Operation & Maintenance
$ Million per year

	A	B	C	D	E	F	G	H
Puget Sound Plants[1]	5.17	6.88	8.35	6.35	8.23	8.82	9.03	12.72
Renton STP[1]*	1.93	3.22	5.95	5.95	5.37	4.38	5.37	4.38
Total	7.1	10.1	14.3	12.3	13.6	13.2	14.4	17.1

[1] Treatment plant including outfall and collection system

*No decision will be made on Renton service area facilities in this plan.

Based on Draft Facility Plan

Table 3- 14
Estimated Average Monthly User Charge Under Each Alternative Per Equivalent Connection*, Dollars Including Renton

Period	Alternative[a]							
	A	B	C	D	E	F	G	H
Existing	3.55	3.55	3.55	3.55	3.55	3.55	3.55	3.55
Condition 1, Future capacity is grant eligible								
1-5 years	4.70	4.80	4.80	4.75	4.85	4.90	5.00	5.05
6-10 "	4.85	5.10	6.00	6.00	6.70	6.65	7.40	7.20
11-15 "	5.50	5.50	7.35	6.80	7.30	7.20	8.05	8.85
16-20 "	6.00	6.15	9.20	7.65	7.85	8.20	8.70	9.55
Average 1-20 years								
Amount	5.25	5.45	7.05	6.40	6.80	6.85	7.45	7.85
Percent increase over:								
Existing rate	48	54	99	80	91	93	110	121
Alternative A	--	4	34	22	30	30	42	50
Condition 2, Future capacity is not grant eligible								
1-5 years	4.70	4.95	5.05	4.95	5.10	5.30	5.25	5.45
6-10 "	4.85	5.80	7.00	7.20	7.40	8.30	8.76	8.95
11-15 "	5.50	6.45	8.45	8.05	9.00	9.15	9.60	11.25
16-20 "	6.00	7.40	11.10	9.55	9.70	10.75	10.55	12.10
Average 1-20 years								
Amount	5.25	6.25	8.15	7.65	8.00	8.60	8.75	9.70
Percent increase over:								
Existing rate	48	76	130	115	125	142	146	173
Alternative A	--	19	55	46	52	64	67	85
Connection Fee (lump sum) Required to Equalize Rates to Condition 1	0	485	670	760	690	1,060	750	1,065
Condition 3, no grant funding								
Average 1-20 years								
Amount	5.25	8.40	13.70	11.10	12.75	13.80	15.20	15.20

*Metro employs a rate structure consisting of a flat charge based on a residential equivalent factor. High strength users are surcharged beyond the nominal rate. Currently there are 425,000 equivalent residential connections.

a. Renton costs are reflected in this table, but decisions on Renton upgrading will not be made in this plan.

health standards would continue in swimming areas in Lake Washington. These impacts would be adverse, major, long-term, reversible and probable.

Treatment plants would continue operations in or near recreational areas at West Point, Alki and Carkeek Park. Details of these impacts are described in each of the site-specific EIS documents.

Health and safety. A negative impact could be associated with bacteria exceeding bathing water criteria at Lake Washington public beaches.

Another highly unlikely safety hazard is accidental leakage of chemicals when they are in transport, or handled on site. Although nearly every U.S. water and wastewater treatment facility uses chemicals, there have been very few chemical-related accidents.

The health and safety problems related to sludge transport and disposal would be as improbable as for any other trucks in transit.

Since there would be no construction, there would be no risk to health or safety in this category.

Legal and institutional. Alternative A does not comply with PL 92-500 secondary treatment requirements nor the Washington NPDES Regulations issued by DOE, which require secondary treatment but do not specify a date. A fine as high as $10,000 per day could be levied against Metro for noncompliance if this alternative were implemented. The details of this are explained in Chapter II.

This impact would be adverse, major, long-term, probable, but reversible (if a secondary treatment facility alternative were implemented).

The Shorelines Management Regulations would not be applicable, since Alternative A includes no construction. No U.S. Army Corp of Engineers permits would be required.

Aesthetics and nuisance. Currently, many of the wastewater facilities are blocked from view either by trees or bluffs, and odor is generally not a major problem except at Alki. This situation would continue under Alternative A. Aesthetics and nuisance related to Alternative A are adverse, minor, long-term, reversible, and definite. For more details the site specific EIS (Volume II) series should be consulted.

Secondary Impacts

The secondary or indirect impacts of Alternative A would result from expanding the Renton plant, sludge disposal methods, and population growth to 2005. The effects of these changes on water quality, energy and natural resources, and the human environment are described below.

Water Quality

The indirect effects of the Renton discharge, unsewered population growth around Lake Sammamish, and leachate from sludge disposal are considered to be secondary impacts on water quality for the Duwamish estuary, Lake Sammamish and groundwater.

Direct effects of population growth on water quality from combined sewer overflows and wastewater flows to treatment plants have been described under primary impacts.

Duwamish estuary. With an average daily discharge of 33 million gallons, the Renton sewage treatment plant would provide an insignificant amount of flow augmentation in summer which may help alleviate summer water temperature problems, but probably does not improve oxygen level. In fact, the discharge may impair oxygen levels as Renton secondary effluent would have a DOE of about 2 mg/l and a BOD of about 10-15 mg/l. Nutrients and Ammonia in the Renton discharge may degrade Duwamish water quality to a moderate degree.

Lake Sammamish. Increasing urbanization around the lake would result in addition of urban runoff, which would contribute loads of nutrients and toxicants to the lake unless controlled.

Groundwater. By 2005, there would be an unsewered population of 327,000 in the Metro area. If septic tanks are used for waste disposal, a detrimental impact on groundwater could result, but information is not available to discern the extent of this impact. Other on-site waste disposal systems are being considered in the Metro 208 plan.

Leachate runoff from sludge disposed at the Cedar Hills sanitary landfill would not be a problem. The soil is quite impervious, limiting groundwater flows to about a foot a year. The leachate waters at Cedar Hills will be collected in a system of pipes now under construction. Runoff streams from the sludge basins visibly have good quality. Impacts at the Pack Forest site will continue to be monitored there.

Energy and Natural Resources

Energy. For Alternative A, a net of 28.13 million equivalent kwh/year of energy per year would be consumed by 2005 at Renton. Included in this would be 26.62 million kwh/year of electrical energy purchased and 1.71 million equivalent kwh/year required to produce the chemicals consumed. There would be no sludge trucking nor energy consideration for anaerobic digestion at Renton. The impact of the energy consumption would be adverse, moderate in magnitude, long-term, irreversible, and definite.

Chemicals. Chlorine would be the only chemical used at Renton, at an annual rate of 500 tons. The impact of chemical usage would be adverse, moderate, long-term, irreversible, and definite. The supply of chlorine is reliable, however.

Human Environment

Secondary impacts on population, employment, and costs are summarized below.

Population and employment. The No Action Alternative would probably not change the growth pattern significantly from the current trend. Since sewers would not be provided in growth areas, growth could be either limited by the ineffectiveness of on-site waste disposal systems or accommodated by their effectiveness. The Puget Sound region has a relatively high environmental quality, and this is expected to continue to attract economic development. This impact can be either beneficial or adverse depending on the characteristics of the development which occurs and the values of the people affected.

The commercial fishing industry would continue as it presently is relative to possible impacts of wastewater facilities.

Operation and managememt employment at Renton would include 21 personnel, plus other Metro related staff. Construction would involve no employees, as no construction is completed under this alternative.

Costs. If Alternative A is implemented, there would be no capital costs for Renton, as indicated in Table 3-13, since no new treatment facilities would be constructed. Renton operation and maintenance would cost $1,930,000 per year. The effect of this on user charge is noted in the primary impact section, since user charges are determined on a Metro-wide basis. Impact of cost would be adverse, minor, long-term, irreversible, and definite.

Mitigation Measures

Because of the no action definition of Alternative A, no mitigation measures can be proposed.

Unavoidable Adverse Impacts

All adverse impacts under Alternative A would be unavoidable. These would include impacts on water quality from combined sewer overflows and primary effluent, related impacts on biology and public health, continued use of plant sites in parks or residential areas, and noncompliance with PL 92-500.

ALTERNATIVE B
METRO COMPREHENSIVE PLAN
(NO ACTION PURSUANT TO PL 92-500)

The description of Alternative B and its projected impacts to the year 2005 are presented in this section.

Description

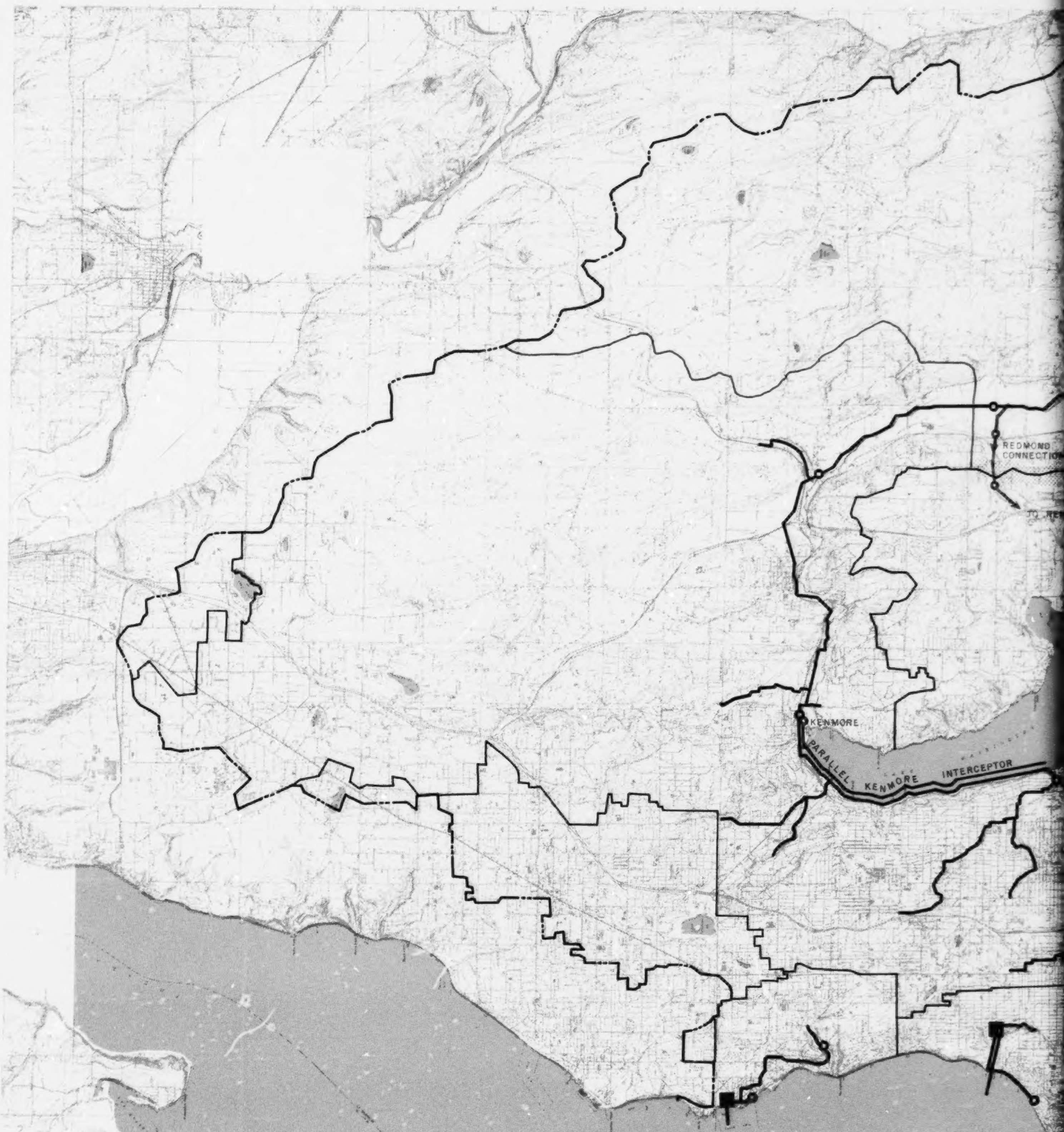
Alternative B continues system upgrading in accordance with the Metro Comprehensive Plan with maintenance of primary treatment at West Point, Alki, Carkeek Park and Richmond Beach. Alternative B represents no action pursuant to Public Law 92-500.

Because the federal law (PL 92-500) is regarded as no action under NEPA in the federal EIS, Alternative B is used as the baseline for comparing impacts of other alternatives. For comparative purposes, Alternative B impacts are also described relative to existing conditions in the impact section.

The use of Alternative B as a baseline is not intended to imply that no action would be taken. In fact, there are improvements proposed that Metro believes are significant. Since these improvements would likely be made by Metro regardless of federal actions, Alternative B is actually a more realistic "no action" alternative than Alternative A for the year 2005.

The major wastewater facilities proposed for Alternative B are illustrated in Figure 3-8. Major features of the alternative are summarized in Table 3-15, including treatment plants, effluent discharges and combined sewer overflows, and major new transfer facilities. The construction schedule and costs for proposed facilities are shown in Table 3-16.

The alternative is further described below in terms of service area, treatment plants (location, treatment process, effluent disposal site), combined sewer overflow control, sludge management, primary impacts, mitigation measures and unavoidable adverse impacts. The indirect implication of the facilities proposed under this alternative on the Renton plant are also described.


REDMOND CONNECTION
TO RE
KENMORE
PARALLEL KENMORE INTERCEPTOR
LAKE WASHINGTON

A.

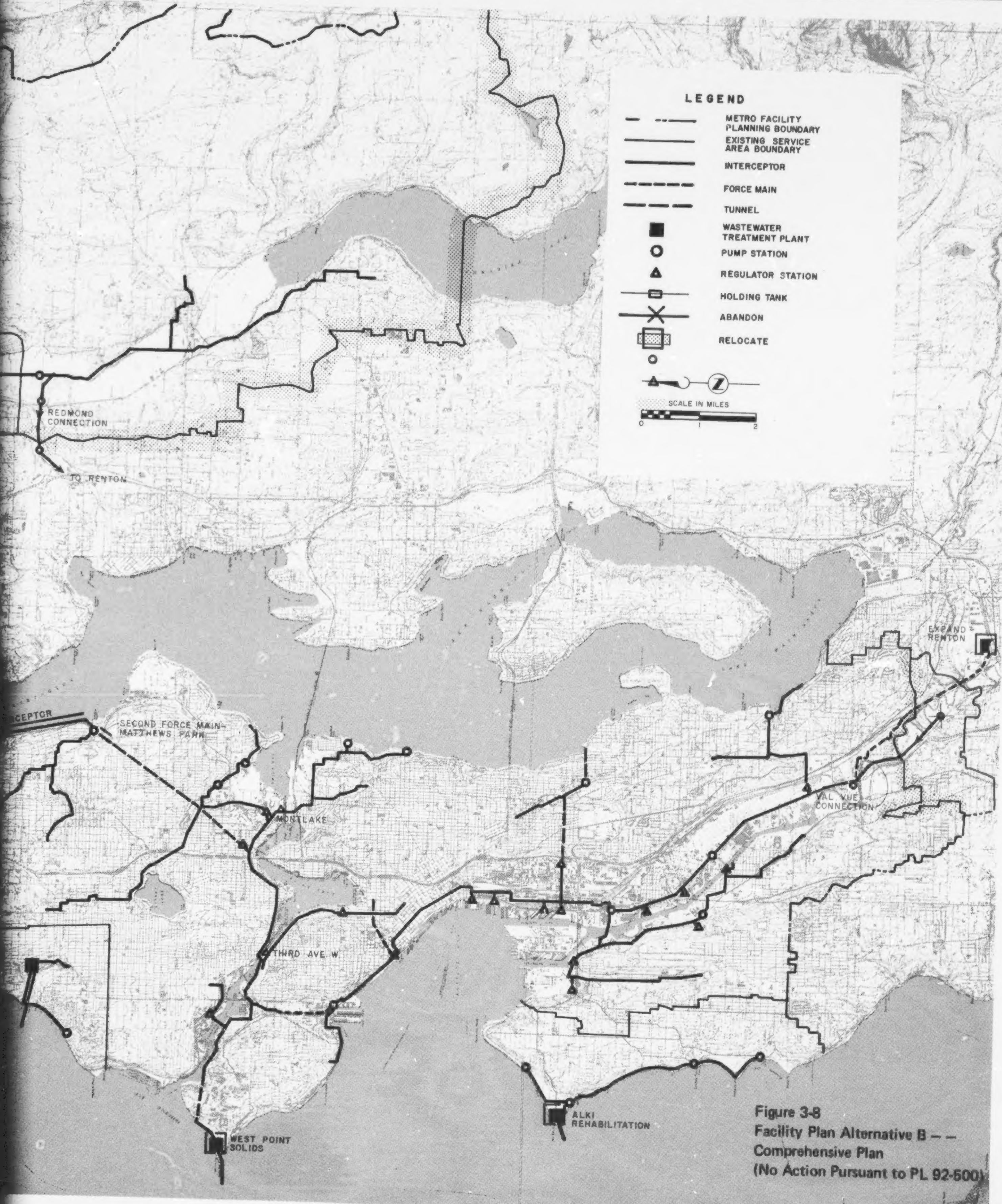

LEGEND
METRO FACILITY PLANNING BOUNDARY
EXISTING SERVICE AREA BOUNDARY
INTERCEPTOR
FORCE MAIN
TUNNEL
WASTEWATER TREATMENT PLANT
PUMP STATION
REGULATOR STATION
HOLDING TANK
ABANDON
RELOCATE
Z
SCALE IN MILES
0
1
2
REDMOND CONNECTION
TO RENTON
EXPAND RENTON
CEPTOR
SECOND FORCE MAIN-MATTHEWS PARK
MONTLAKE
VAL VUE CONNECTION
THIRD AVE W.
ALKI REHABILITATION
WEST POINT SOLIDS

Figure 3-8
Facility Plan Alternative B — —
Comprehensive Plan
(No Action Pursuant to PL 92-500)

B

Table 3-15

Alternative B - Metro Comprehensive Plan (No Action Pursuant to PL 92-500) (Baseline)

TREATMENT PLANTS

	WEST POINT	ALKI	CARKEEK PARK	RICHMOND BEACH	RENTON*
Process	Primary	Primary	Primary	Primary	Secondary
Improvement Completed	Sludge enlargement Phase I - 1985 Phase II - 1995	Improved outfall - 1986	None	None	1995
Flow (mgd) 2005 (Average/Peak)	142/350	10/30	3.5/20	2.5/9	86/223
Disposal	Puget Sound	Puget Sound	Puget Sound	Puget Sound	Duwamish

COMBINED SEWER OVERFLOWS (2005)

	Flow (Million Gallons/Yr)	Solids (Tons/Yr)	BOD (Tons/Yr)
Lake Washington	22.4	20.4	5.58
Lake Sammamish	0	0	0
Portage Bay/Montlake Cut	228	241	59.3
Lake Union	56.6	51.4	14.1
Ship Canal/Salmon Bay	254	23[illegible]	63.3
Elliott Bay	358	325	89
Alki Beach	5.46	4.95	1.36
Duwamish/Green River	251	227	62
Total	1175	1101	295

TREATMENT PLANT DISCHARGES

	Flow (Million Gallons/Yr)	Solids (Tons/Yr)	BOD (Tons/Yr)
West Point	56,200	14,000	18,800
Alki	3,650	913	1,220
Richmond Beach	912	228	304
Carkeek Park	1,530	380	510
*Renton	31,350	1,973	1,968
TOTAL	93,642	17,496	22,798

MAJOR NEW TRANSFER FACILITIES

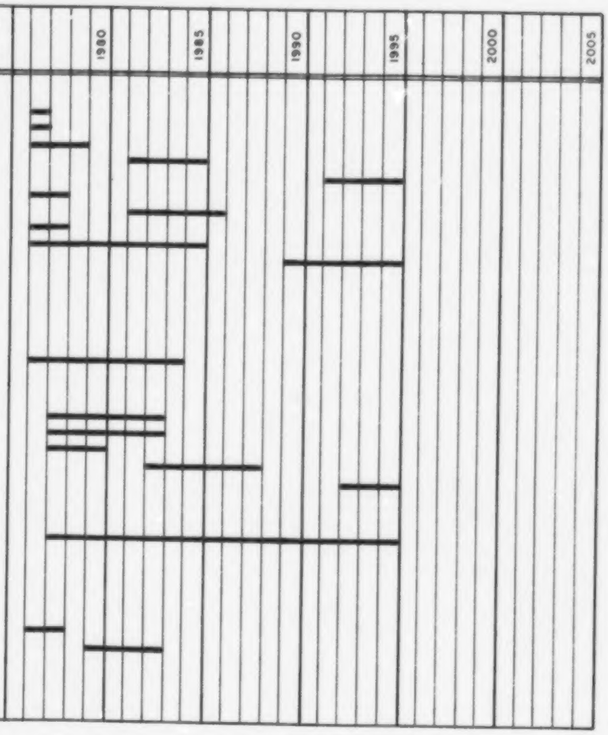
Location	Year Completed
Second Kenmore Interceptor	1983
Val Vue Connection (to West Point)	1980
Redmond Connection - Phase I	1987
Redmond Connection - Phase II	1995

*Not included in proposed facilities plan for Puget Sound plants

Table 3-16

Alternative B -- Project Costs and Construction Staging

Facility Component	Project Cost $ million ENR-CCI 2600
Treatment Plants	
Richmond Beach Misc. Improvements	0.1
Carkeek Park Misc. Improvements	0.1
West Point - Interim Improvements	4.8
West Point - Sludge Enlargement 2	7.1
West Point - Sludge Enlargement 3	7.1
Alki - Interim Improvements	0.3
Alki - Plant Modifications	12.7
*Renton - Interim Improvements	0.4
*Renton Enlargement 2	25.5
*Renton Enlargement 3	35.0
Subtotal - Treatment Plants	93.1
Collection System	
Rehabilitation of Existing Collection System	15.6
*Increased Transfer Capacity within West Point Existing Sewered Area	
Second Kenmore Interceptor	22.2
Kenmore P.S. (Permanent)	8.5
Val Vue Connection (to West Point)	5.5
Redmond Connection - Stage 1	14.0
Redmond Connection - Stage 2	1.0
Increased Transfer Capacity and Rehabilitation within Renton Service Area	27.2
Subtotal - Collection	94.0
Combined Sewer Overflow Control	
Montlake Regulator Station	0.8
Third Ave. W. Regulator Station	0.5
Subtotal - Hold and Transport CSO	1.3
Total Capital Cost	188.4



*Renton facilities are not part of the proposed facilities plans.

Service Area

The service area of Alternative B would be as shown in Figure 3-1. Relative to existing conditions, the West Point service area would be modified by transferring the North Lake Sammamish service area to Renton by the Redmond connection, and transferring Val Vue flows to West Point. To serve increased flows from the North Lake Washington areas would require construction of a Kenmore parallel interceptor. The Richmond Beach, Carkeek Park and Alki service areas would not change.

The new transfer interceptors that would be needed to facilitate the service area modifications would be the Redmond connection to Renton (1987 and 1995), the Val Vue connection to West Point (1980), and the second Kenmore interceptor to West Point (1983). The construction schedule for these collection system modifications would be as in Table 3-16.

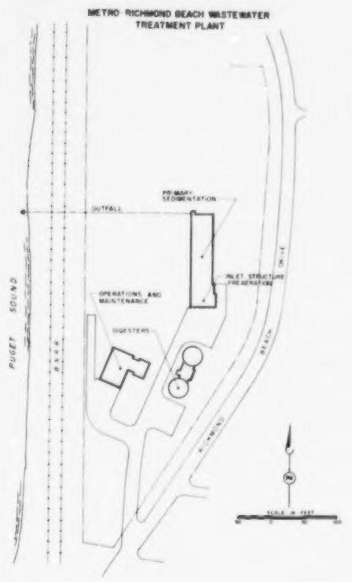
Treatment Plants

The wastewater treatment facilities under Alternative B would be as shown in Table 3-15. Plant layouts are shown in Figure 3-9. The West Point, Alki, Carkeek Park, and Richmond Beach plants would continue to provide primary treatment, discharged to Puget Sound. The Richmond Beach treatment plant has primary capacity to serve projected 2005 flows. Carkeek Park has primary capacity to serve all but peak storm flow, which would continue to be bypassed during high flow periods. West Point has adequate primary capacity to serve 2005 non-storm flows. Dry weather flow increases over existing conditions would be attributed to additional sewered population in the service areas.

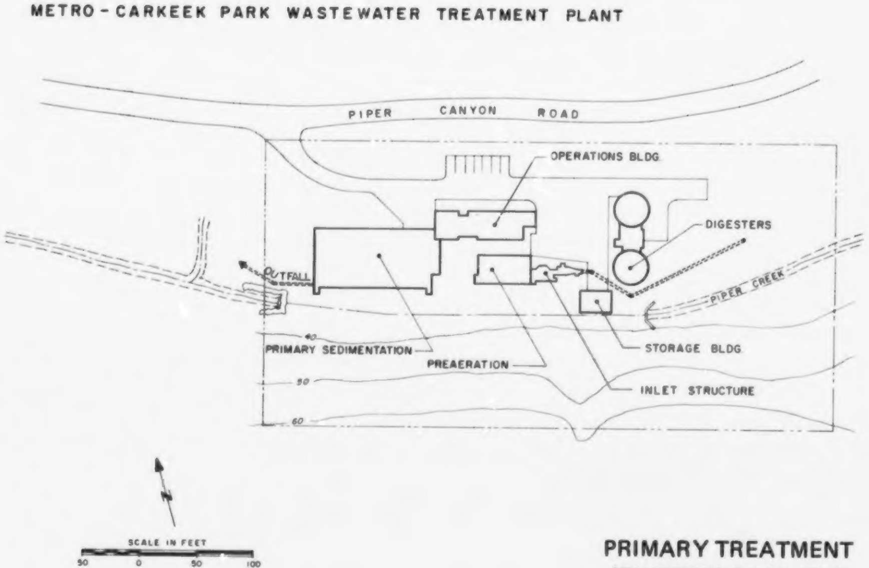
Improvements outlined in the comprehensive plan would be carried out. For example, more sludge digesters at West Point would be provided in 1985 and 1995. At Alki, major improvements would be made to the existing pretreatment and preaeration works and chlorination facilities; the outfall would be improved by extending it.

Combined Sewer Overflows

In Alternative B, combined sewer overflows would increase by about 12 percent relative to existing conditions due to

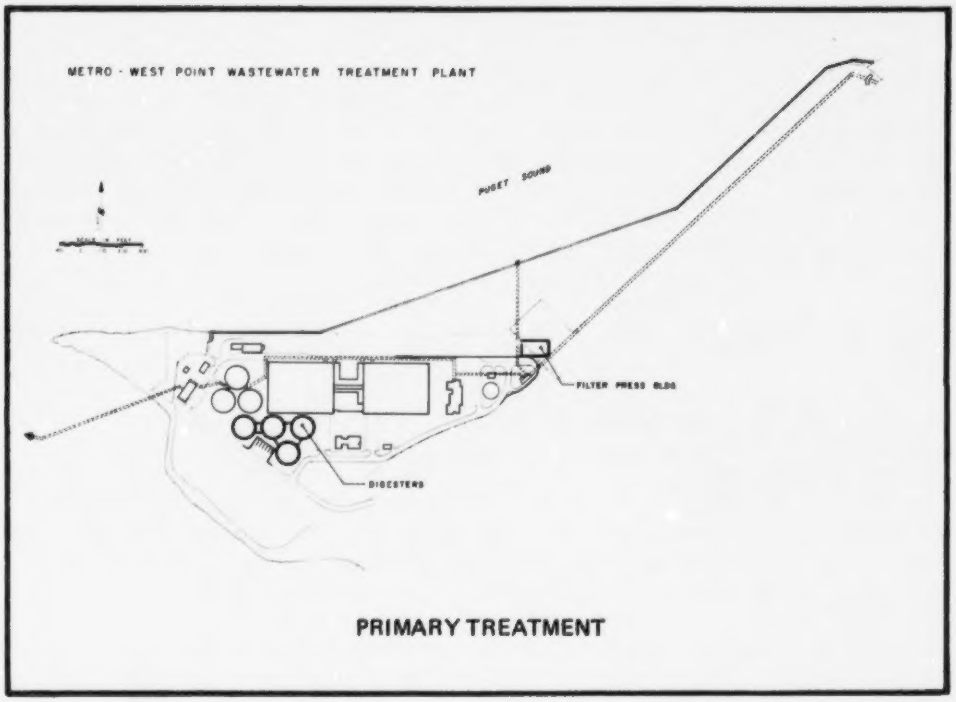

METRO RICHMOND BEACH WASTEWATER TREATMENT PLANT
OUTFALL
PRIMARY SEDIMENTATION
INLET STRUCTURE PREAERATION
OPERATIONS AND MAINTENANCE
DIGESTERS
PUGET SOUND
RICHMOND BEACH DRIVE
N
SCALE IN FEET
50
0
50
100

PRIMARY TREATMENT
(EXISTING FACILITY)


METRO-CARKEEK PARK WASTEWATER TREATMENT PLANT
PIPER CANYON ROAD
OPERATIONS BLDG.
DIGESTERS
OUTFALL
PIPER CREEK
40
PRIMARY SEDIMENTATION
PREAERATION
STORAGE BLDG.
50
INLET STRUCTURE
60
SCALE IN FEET
50
0
50
100

PRIMARY TREATMENT
(EXISTING FACILITY)

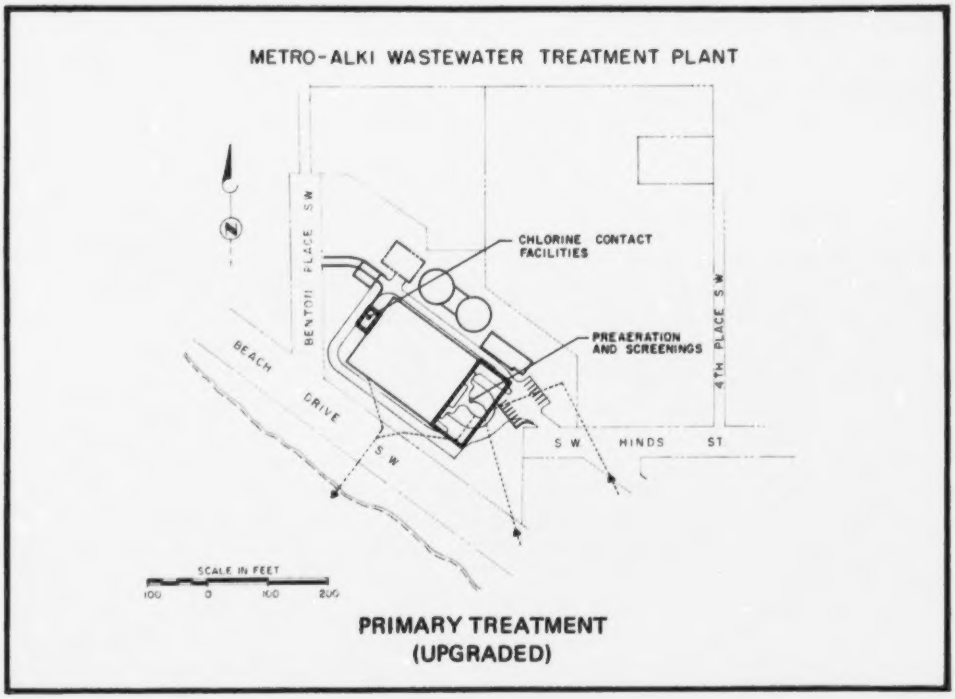
Figure 3-9
Alternative B — — Plant Layouts (Sheet 1)



METRO - WEST POINT WASTEWATER TREATMENT PLANT

PUGET SOUND
FILTER PRESS BLDG
DIGESTERS

PRIMARY TREATMENT



METRO-ALKI WASTEWATER TREATMENT PLANT

CHLORINE CONTACT FACILITIES
PREAERATION AND SCREENINGS
BENTON PLACE S.W.
4TH PLACE S.W.
BEACH DRIVE S.W.
S.W. HINDS ST
SCALE IN FEET
100
0
100
200

PRIMARY TREATMENT
(UPGRADED)

Figure 3-9
Alternative B — — Plant Layouts (Sheet 2)

population growth in the service areas. The current program of maximizing existing in-line storage capacity for control of combined sewer overflows would be continued with construction of regulator stations at Montlake (by 1978) and Third Avenue West. However, overflows of combined sewage would increase in the Lake Union Ship Canal area due to increased flows from the northern West Point service area.

Sludge Management

The sludge management system for Alternative B would be similar to the present situation, with expansion of handling facilities to accommodate the added solids loads from growth in service areas. Anaerobic digestion would be provided, with methane used to the extent possible at plant sites. West Point would remain as the major solids processing center, receiving untreated Renton sludge in the plant influent plus digested sludge trucked in from Carkeek Park and Richmond Beach. Enlargement of sludge facilities at West Point, specifically adding digesters and enlarging dewatering capability, would be scheduled for 1985 and 1995. The existing sludge digestion facilities at Richmond Beach and Carkeek Park would be adequate to serve projected 2005 flows. Processed sludge would be trucked to Cedar Hills landfill and the Pack Forest research site.

Renton

Although the Renton service area and treatment plant are not included in the proposed facilities for Alternative B, the alternative would have secondary or indirect impacts on the Renton plant. Due to an increase in the Renton service area (transferred from West Point) and the projected growth to 2005 in the Renton service area, the plant capacity would be expanded in two stages (1985, 1995) to 86 mgd average, 223 mgd peak. Since no action would be taken pursuant to PL 92-500, the treatment process would continue as secondary treatment, discharging effluent to the Duwamish River. Sludge would be treated at West Point, then trucked to disposal sites.

Primary Impacts

The direct impacts from this alternative for the Puget Sound plants are described below. Indirect impacts and the effects from the Renton plant are described in a separate section on secondary impacts.

Geology, Soils and Topography

Alternative B is expected to have a minor effect on slope and soil stability, erosion, deposition, topography and soil profiles from intended construction projects. Three new digesters would be installed at West Point. The impacts of this action are discussed in the West Point site document which is Volume II of this series.

Impacts would continue at existing sludge disposal sites; all alternatives contain the interim disposal site at Cedar Hills which with the loadings under this alternative would last 30 years under current practices. Other potential disposal sites have been identified by the facilities planning engineers, but no decision is anticipated in the Facility Plan. Pack Forest research and impact analysis will continue.

Alternative B also includes the construction of the Kenmore parallel interceptor along the northwest shore of Lake Washington. If the "Lake Line" is chosen, it would involve a 4000-ft section along the north shore of Lake Washington and about five miles underwater to Matthews Park. Construction can be expected to generate localized turbidity and alteration of benthic sediments. Turbidity, accelerated erosion and siltation potential are greatest at the interface between shore and water sections where such problems are difficult to control because the interface tends to be an area of much activity. Any temporary onshore staging area also has the potential for increasing local turbidity, increasing shoreline and nearshore erosion and siltation (Metropolitan Engineers Task D3, 1976).

The "Force Main" option, an option to the lake line route of the Kenmore parallel, would use the Burke-Gilman Trail as a land route. Because the Burke-Gilman Trail has already been altered (serving formerly as a railroad line), use of this route should have minimal long-term impact upon existing geology and soils. Adverse impacts should be limited to the construction period (less than two years) and may include dust, possible erosion and siltation, increased turbidity in runoff and local drainage systems. Despite the fact that the "Force Main" option is a land route, large portions of it lie within the shoreline area, and care must be taken to confine construction-related impacts to the site itself and to prevent turbidity and siltation in the lake (Metropolitan Engineers Task D3, 1976).

Present hazard risks would continue at existing sites. Earthquake risk at the Kenmore parallel would be a function of foundation stability. Depending on the structures encountered, moderate or severe precautions would need to be taken to protect the structure. Shore and lake bed sediments are expected to be of greater risk, however.

Air Quality and Odors

Sludge trucking traffic from Richmond Beach to West Point and from West Point, Alki, and Carkeek Park to the Cedar Hills landfill would emit approximately 710 grams of hydrocarbons, 4435 grams of carbon monoxide, and 3230 grams of nitrogen oxides per day. Emissions from sludge truck traffic to the Pack Forest site would be greater due to a longer travel distance. Operating personnel traffic to wastewater treatment plants would generate approximately 3590 grams of hydrocarbons, 45,700 grams of carbon monoxide and 5920 grams of nitrogen oxides. The combined emissions would amount to less than 0.01 of 1% of Seattle's total daily emissions of hydrocarbons, carbon monoxide, and nitrogen oxides. The air pollutants emitted under this alternative would have a negligible, adverse, long-term, reversible impact on the air quality of the Seattle area.

The potential for odor problems at each of the treatment plants would remain about the same as at present, because the plants would continue primary treatment. Enlargement of the sludge handling facilities at West Point in 1985 and 1995 would increase the potential for odor problems there. The increase of combined sewer overflows from additional sewered population (relative to 1975 conditions) to Lake Washington, Lake Union, the Ship Canal, and Portage Bay would increase the occurrences of odors arising from CSO's in these areas. The potential odor problems associated with this alternative would have a minor, long-term, adverse, reversible impact on the environmental quality of the Seattle area.

Water Quality

Population growth and expanding urbanization will increase runoff and wastewater flows to treatment plants. As a result, combined sewer overflows to Lake Washington, Lake Union, and the Ship Canal would increase by about one-third over present (1975) flows. The total treatment plant flow to Puget Sound would increase by about 30 percent relative to 1975.

Lake Washington. The primary effect on Lake Washington water quality would be from increasing CSO's at 41 points along the lake's western shore. Data on combined sewer overflow occurrence and quality are limited, as described under Alternative A, particularly for potentially toxic materials. Future overflows are expected to increase by 36 percent (relative to 1975) to 22.4 million gallons flow, 20.4 tons of solids and 5.6 tons of BOD per year (Metropolitan Engineers, 1977). These inputs could have moderate negative impacts, limited in extent to waters along the western shore, as suggested by dye studies (Metro taff, 1976). The impacts are judged to be of long duration because CSO's are intermittent but continuing, and reversible for most parameters except PCB's, heavy metals, pesticides and toxicants which accumulate in the lake. While PCB's have been banned, the continued use of existing supplies will affect water quality for some time. Elevated total coliform bacteria counts could result in unsanitary conditions (greater than 1000 MPN/100 ml) for bathing for a few days after an overfow.

Lake Union/Ship Canal. Because of additional sewered population, combined sewer overflows to Lake Union/Ship Canal would increase by about 36 percent (relative to 1975). Information on present CSO occurrence and quality is limited, as described under Alternative A.

Lake Union/Ship Canal receives overflows at 32 points along its length for a total volume of 311 million gallons per year under Alternative B. While data are limited, it appears that nearshore freshwater organisms may be subjected to high levels of mercury, PCB's and DDT and its derivatives, as well as to BOD concentrations of 10-29 mg/l and suspended solids concentrations of 48-148 mg/l. Annual loadings of BOD and solids to the Lake Union/Ship Canal would be 75 and 282 tons, respectively, about a 37 percent increase over 1975 conditions.

Adverse effects of overflows would probably be minor in the Ship Canal, which is relatively well flushed. Lake Union, which has poor circulation, would receive (from 4 major and 4 minor overflows) about 56.6 million gallons a year. The impacts from the projected increase of CSO's of 36 percent would probably be moderate, because the increase is not large, but felt throughout the Ship Canal. Except for the accumulation of heavy metals, PCB's, and pesticides, the adverse effects of CSO's are reversible.

Other freshwaters. Lake Sammamish and the Green, Cedar and Sammamish Rivers would not be directly affected by this alternative.

Duwamish estuary. Impacts from combined sewer overflows on the Duwamish estuary would be the same as under existing conditions or Alternative A. The adverse impacts attributed to approximately 251 million gallons per year of CSO's would be overshadowed by the 31,400 million gallons per year discharged from Renton (described under secondary impacts).

Puget Sound. Under Alternative B, wastewater flows to Puget Sound would increase by about 30 percent relative to existing conditions; most of the added flow would be from West Point. The continuation of the Metro Comprehensive Plan would produce no measurable effects on temperature, dissolved oxygen, or salinity at the beaches or offshore. Some localized impacts such as small decreases in dissolved oxygen or increases in turbidity and nutrients near outfalls would be expected to continue. A difference in Alternative B relative to Alternative A would be the extension of the Alki outfall, which would probably improve beach conditions nearby. Overall, the effects of wastewater treatment plant discharges would continue to be slightly adverse because Metro inputs to Puget Sound would increase relative to present conditions.

Combined sewer overflows to Elliott Bay and off Alki Beach would remain at 1975 levels. From the standpoint of microbiology and related public health concerns, the adverse impacts of continued CSO's and discharge from the outfalls would be significant, as violations of state fecal coliform standards for commercial shellfish waters would continue. Impacts would be extensive, because the entire shoreline in the Metro area appears to be affected. Effects would be long-term, as the occurrence of problems is intermittent but continuing, and reversible, as pathogens are generally inactivated after a certain period. Intertidal and nearshore subtidal clams would probably be unsafe due to bacterial or viral contamination from wastewater treatment plant or CSO discharges.

The present effects of heavy metal discharges to Puget Sound, which would continue under Alternative B, are not well understood. Details on metals have been described under existing conditions and Alternative A. Since wastewater flows would increase under Alternative B, heavy metals would also be expected to increase. With respect to metals, the impacts of Alternative B on Puget Sound water quality are judged to be minor, limited in extent, and long-term along beaches. Nearshore and offshore waters presently are high in lead and cadmium concentrations, but these levels are not attributable to Metro from existing data. Therefore, the net effect of heavy metals from Metro outfalls and CSO's under Alternative B on nearshore/offshore water is unknown, but probably minor.

Toxicants would probably increase with the additional wastewater flows of Alternative B. It is possible that toxicants in Metro discharges are adversely affecting beaches at present, but the levels of toxic constituents in receiving waters have not been determined. Impacts at some beaches may be more likely due to CSO's or outflows from the industrialized Duwamish area (including Renton effluent) which flow from the Duwamish River Estuary into Elliott Bay and move toward West Point. Contributions of toxicants to nearshore and offshore waters would probably be smaller, primarily because CSO's and the Duwamish discharge would be likely to reach them only in small amounts.

With the banning of PCB manufacture, use and sale after January 1978, the presence of these toxicants in effluents and CSO's is expected to begin to decline. However, future growth in commercial and residential areas may produce greater inputs of other toxicants to Puget Sound through sewage effluent and CSO's. As many toxicants and PCB's do not degrade readily, such chemicals already in local waters will be available for biotic uptake and concentration for a long time. For the purposes of 20 year facilities planning, their presence is considered to be long-term and essentially irreversible.

Groundwater. Alternative B is not expected to exert any direct impacts on groundwater quality. Effluents would be discharged to Puget Sound and would not be capable of infiltrating to groundwater.

Flood hazard. Floods are not expected to cause problems at any of the treatment plants because all of the sites are above the 100 year flood level.

Biology. The impacts on terrestrial and shoreline habitats, Puget Sound, the Duwamish estuary, freshwater environments, and rare or endangered species are described below.

Terrestrial habitats. Alternative B involves no site expansions, but includes the construction of a Kenmore parallel interceptor. While the exact route of this line is undecided, it is certain that some temporary minor disturbance of terrestrial habitats would occur. The impacts of digesters to be built at West Point are discussed in the site-specific document which is Volume II of this series. No direct impacts on non-urban terrestrial forest or prairie lowland habitats are expected. Indirect impacts of population growth are described in a separate section on growth.

Shoreline habitats. The effects of Alternative B on shoreline habitats would result from increased overflows to Lake Washington, Lake Union/Ship Canal, and Portage Bay and from the construction of the Kenmore parallel interceptor.

The Kenmore parallel interceptor construction (4000 feet along the northwest Lake Washington Shore, then under water to Matthews Park) could cause turbidity, accelerated erosion and siltation in nearshore waters and alteration of benthic sediments, very possibly near salmon spawning areas. Benthic organisms and salmon eggs could be buried; aquatic plants could be affected by decreased light levels due to turbidity. The effect could be major, but would be limited in extent to nearshore areas along a part of Lake Washington; it would be short-term and reversible as the biota readjust to new environment. Salmon would probably not return to silted areas for spawning, as the fish require clean, well-aerated gravels.

Sewer overflows, BOD and solids loads to Lake Washington, Lake Union and the Ship Canal would increase 36% relative to existing conditions under Alternative B. It is assumed that loadings of oil, grease, metals and toxicants would probably increase similarly. PCB's would begin to decline after 1978, unless reservoirs of these toxicants remain in the interceptors to be partially flushed with each storm.

The increase in CSO's is judged to be moderate. Limited information to date indicates effects of CSO's on freshwater biota (Metro Staff, 1976) are sever, but limited in extent.

The projected 36% increase could probably increase the extent and severity of the effect for a similar amount as more organisims would be affected by the solids, BOD, metals, pesticides, toxicants, oil and grease.

The intertidal. Elements of Alternative B which would impact the intertidal are the extension and improvement of the Alki outfall, increased flows and loads by 2005 from all treatment plants (30 percent above existing conditions at West Point, 21 percent at Alki, 33 percent at Carkeek and 52 percent at Richmond Beach), and continued sewer overflows approximately at present rates.

Improvements to the Alki outfall would reduce the concentrations of nutrients, pathogens, solids and other parameters that may affect local intertidal biota. Increased algae biomass at Alki may continue since it could be due to nutrients being carried shoreward from the outfall during part of the tidal cycle (Matsuda, personal communication, 1977). Effects on the kinds and numbers of intertidal clams are difficult to assess since, like algae, they are harvested for food.

Eddy systems forming north and south of Alki Point and West Point, and onshore water movement at Carkeek Park and Richmond Beach during part of the tidal cycle could cause diluted wastewater to reach beaches. Based on current patterns and dye studies, the authors consider it highly likely that effluent enters the intertidal zone at all outfall sites, but with unknown frequency. Effects found to date on intertidal organisms which could be attributed to effluent are primarily on the floral assembly - algae and diatoms at West Point. Limpets, among the main consumers of these plants, show increased growth rates. The expected 30 percent increase in flows from West Point (relative to 1975) could have a concomitantly larger effect, especially if industrial growth keeps pace with population growth.

At Alki, combined sewer overflows would continue to contribute the equivalent of 0.1 to 0.2 percent of the annual flow from the Alki facility (about half a day's flow), 0.5 - 0.6 percent of the solids and 0.1 percent of the BOD. With respect to the intertidal, the improvement of the outfall would be more important than the continued level of sewer overflows, although the overflows contain essentially untreated wastes.

Major CSO's would continue at present levels to Elliott Bay, one of the few intertidal areas influenced by CSO's.

The adverse effects limited to CSO points that have been observed to date would continue under Alternative B. Non-degradable metals and toxicants would continue adverse. irreversible impacts on biota. In contrast, the effects of effluents appear to be minor-to-moderate, adverse, and affect greater portions of the shoreline. The parameters which appear to be most involved are nutrients. It is recognized that a number of other parameters in effluents which may also be having effects have not been measured. As metals are generally higher in intertidal biota near outfall areas at this time, and flows and loads are expected to increase in the future, metals could increase to levels approaching U. S. and Canadian standards for mercury and lead. While coliform bacteria have not been measured in intertidal shellfish, the overlying waters fail to meet State bacterial standards. As edible shellfish are found near all four outfall sites, the potential effects on public health of metals and pathogens are a consideration. Eelgrass beds near Carkeek and Alki, which are important feeding and breeding areas for commercial fishes and their prey, could also be subject to effluent.

Nutrients, BOD and solids would probably affect these already rich areas little; toxicants or pesticides could accumulate, affecting the fishes, their prey and their predators. In the absence of data on metals, toxicants and the frequency of exposure to pollutants, the magnitude of the impact is unknown.

Puget Sound. The intertidal, nearshore subtidal, and offshore bottom, free-swimming and planktonic organisms in the study area would continue to be subject to effects of combined sewer overflows at present levels, increased flows and loads from treatment plant effluents, plus runoff, septic tank seepage, boat wastes, dredge spoil dumps, and other pollutant sources.

The difference in effects between 1975 conditions and Alternative B would be due primarily to the improvement in the Alki outfall and increases in effluent flows. Improving the Alki outfall is not expected to affect phytoplankton production. At West Point, additional nutrients could generate further increases in the phytoplankton productivity extremes noted to date within a mile of the West Point outfall. Thus, the potential effect is judged to be minor and limited in extent,long-term, reversible and adverse, as the Sound is naturally highly productive.

For zooplankton, the present effect is judged to be unknown and future effects unpredictable. Metals would probably remain higher in zooplankton near outfall areas than at background areas, however (Schell *et al.*, 1977).

The effects on the benthos identified in PSIS studies (correlated with West Point and Carkeek plume positions) would continue and perhaps increase. Although Richmond Beach and Alki were not sampled, the benthic conditions at these sites are probably similar, based on water circulation patterns. Thus, the adverse effect of increasing flows would continue to be moderate-to-major but probably somewhat more extensive. The area affected by the Alki plume would be transferred further offshore and the area presently affected would probably return to a former condition.

Nearshore free-swimming (nektonic) forms (juvenile salmon, herring, and other commercial fish that frequent the outfall pipe, kelp, or eelgrass areas in daytime or at night) could continue to be occasionally exposed to levels of chlorine at higher than "safe" levels and perhaps to other constituents in effluent.

Localized effects of additional effluents in nearshore areas could affect herring populations directly or through their zooplankton prey and thus affect salmon and other organisms which feed heavily on herring in open waters (Miller _et al_., 1976).

Changes detected in fish species composition at West Point, discussed in Chapter II, would continue under Alternative B and could be more pronounced with larger flows in the future. Impacts could result from effluent-caused changes in benthic prey species and/or habitat changes due to the outfall pipe itself. Higher disease incidence in fish around the outfalls could continue, although the relative influence of crowding, effluent toxicity and toxicants has not been determined. The overall effect is judged to be adverse, major, but limited in extent, of long duration and probably reversible.

While no data are available, it is possible that offshore nektonic organisms may also be occasionally affected by chlorine, pathogens or toxicants if they swim into or through the effluent field, or if they feed in nearshore areas at night (Brungs,1976; Mattice & Zittel, 1977). Peaks of chlorine at the diffuser of 0.02 mg/l and higher may expose nektonic organisms congregating at the outfall to chlorine exceeding "safe" levels during slack water periods. The potential effect on these organisms is considered to be adverse, minor, limited in extent, of short duration and reversible, even with increased effluent flows and no improvement in chlorination facilities.

Commercial and sport fisheries. Salmonid runs up the Ship Canal and salmon spawning areas in Lake Washington could be further affected by about a 36 percent increase in combined sewer overflows (relative to 1975 flows). In Lake Washington, reductions in dissolved oxygen, enrichment of nutrients, and additional loads of toxicants could create locally unfavorable conditions for commercial fish spawning areas, as described under biology.

Herring off Alki would be affected by combined sewer overflows at existing levels, but the extension of the Alki outfall would be beneficial by limiting the concentration of effluent reaching the beach or curtailing its presence there.

The Duwamish estuary. Combined sewer overflows to the Duwamish would continue at approximately 251 million gallons per year with impacts comparable to existing conditions or Alternative A. Except at localized points near the overflow points, effects of CSO's would be overshadowed by the Renton wastewater treatment plant discharge (described under secondary impacts), industrial discharges and urban runoff.

Freshwater environments. These are important habitats for a variety of organisms, including sport and commercial fishes.

1. Lake Washington. Combined sewer overflows, a number of which discharge into salmon spawning areas, would increase 36 percent over 1975 levels. Based on limited sampling at one overflow point, impacts of present overflows were significant; no macroscopic life was found near the outfall. With future increased overflows, the effects, already major in limited areas along the western shore, would become more extensive, long-term and irreversible (due to metals and toxicants). Effects on offshore biota would probably continue to be minor, as CSO's tend to move along shore rather than into open waters.

The construction of the Kenmore parallel could cause major, extensive, but short-term increases in turbidity and generally disrupt 4000 feet of the shoreline and nearshore waters and biota of northwest Lake Washington. Salmon spawning areas, which require clean gravel, could possibly be silted over. Construction noise would probably frighten off fish and wildlife. The adverse effect is judged to be major but limited, short-term and reversible. Offshore areas would receive lesser effects.

2. Lake Union/Ship Canal. Increased CSO flows of about 36 percent (relative to 1975) would place further stress on an already stressed biota. Overall impacts are unknown, but data available at one overflow suggest that no visible life exists near the outfall. Assuming this effect is typical of all overflows along the canal, the effects of increased flows would be major, limited in extent, though less so than at present, long-term as CSO's could continue; and irreversible if they contain toxicants and metals, which seems likely.

3. Other freshwaters. Biota in Lake Sammamish, Sammamish River, Cedar River and Green River could not be directly affected by this alternative.

Rare or endangered species and critical habitats. No listed endangered species are recorded from the study area. Critical habitats, which include salmon spawning and rearing areas, fish migration routes, waterfowl resting areas, and lake shallows have been discussed in previous sections.

Energy and Natural Resources

Energy and chemical consumption are summarized in Table 3-17.

Energy. For Alternative B, a net of 25 million equivalent kwh/yr of energy would be consumed in 2005 by the Puget Sound plants. Included would be 32 million kwn/year of electrical energy purchased. This is equivalent to the amount of electric energy 1600 households would consume per year, and constitutes approximately 0.16% of the projected electrical energy consumption of Seattle in 2005 (see Appendix E).

Table 3-17 shows the breakdown of total energy consumption on a plant-by-plant basis. The greatest energy consumption would be in the form of electricity. Chemicals account for about 10-25 percent of energy consumption and sludge trucking for less than 3 percent. In the anaerobic digestion of sludge, there sould be a net production of energy because of methane formation. It can be expected that about half of the methane would be used at the plant and about half would be flared off.

The impact of the energy consumption would be adverse,

TABLE 3-17

ENERGY CONSUMPTION FOR ALTERNATIVE B

	PLANT				
	Richmond Beach	Carkeek Park	West Point	Alki	Total
Onsite Energy					
Purchased electricity (kwh x 10^6/yr)	0.63	0.97	27.91	2.35	31.86
Produced by digestion (kwh x 10^6/yr)	(0.32)	(0.48)	(29.85)	(0.85)	(31.5)
Consumed by digestion (kwh x 10^6/yr)	0.13	0.19	11.94	0.34	12.60
Offsite Energy					
Chemicals (kwh x 10^6/yr)	0.14	0.25	8.68	0.59	9.66
Sludge Trucking (kwh x 10^6/yr)	0.03	0.03	2.58	0.11	2.75
TOTAL	0.61	0.96	21.26	2.54	25.37

moderate in magnitude, long-term, irreversible and definite.

Chemicals. Chlorine consumption would be 2,825 tons annually; 40 tons at Richmond Beach, 75 tons at Carkeek Park, 2535 tons at West Point, and 175 tons at Alki. West Point would also use 80 tons per year of polymers to aid in the coagulation of sludge. The supply of chlorine and polymer is highly reliable. The impact of chemical usage would be adverse, minor, long-term, irreversible; and would definitely occur if Alternative B is implemented in its present state.

Human Environment

Alternative B would have negative impacts on some aspects of the human environment.

Land use. The only new impacts on land would be due to construction of the Redmond connection, Kenmore parallel interceptor, the Val Vue connection, the Montlake and Third Avenue regulator stations, and the Kenmore pump station. Since the Kenmore parallel interceptor would pass within 200 feet of the Lake Washington shore, and the Montlake regulator station may be built within 200 feet of the Ship Canal, these would require a building permit from the Shorelines Management Master Program of Seattle. These land use impacts during construction would be adverse, major, short-term, and definite.

Legal and institutional. Alternative B does not comply with PL 92-500 nor the Washington NPDES Regulations which require secondary treatment. A fine as high as $10,000 per day could be levied against Metro for noncompliance, explained in Chapter II. This impact would be adverse, major, long-term, and probable.

Washington public health regulations for coliform standards would still be exceeded at Lake Washington public beaches. No U. S. Army Corps of Engineers permits would be required.

Agency goals. It is speculative whether Alternative B fulfills the King County Utilities Development policy of "installing trunk utility lines in advance or at the time of development", and its policy that "where pollution conditions now exist, all possible steps should be taken to correct such conditions." This alternative does not alleviate the frequent odor problem at Alki, which (in addition to affecting the Alki residents directly) conflicts with the PSCOG goal of maintaining the natural beauty and liveability of the region. This alternative fulfills in part the objectives of Goals for Seattle, that "The city should undertake all means reasonable and feasible to ensure water purity to meet health standards and protect the environment, and to undertake efforts to meet Federal Water Pollution Control Act requirements by 1984; and to ensure clean water to protect wildlife, vegetation, and recreation areas." These impacts on a whole are adverse, major, long-term, reversible, and definite.

Employment. There would be about 150 employees for five years required for the construction involved in Alvernative B. Operation and management employment would require a total of 86 employees at West Point, Alki, Richmond Beach, and Carkeek Park.

Costs. For Alternative B, the estimated capital costs for constructing new treatment facilities, collection systems, effluent disposal sites, sludge handling and disposal facilities (excluding Renton) would be $81,900,000 (1976 dollars) as summarized in Table 3-13 (Metropolitan Engineers, 1977). This is 0.09 percent of the $95,902 billion estimated by the EPA for implementation of PL 92-500 throughout the country (EPA, 1976). The operation and maintenance costs (excluding Renton) would be $6,880,000 per year, as shown in Table 3-13 (Metropolitan Engineers, 1977).

The estimated average monthly user charge per equivalent connection for the next 20 years would be $5.45 per month if all future facilities to 2005 are grant eligible, as shown in Table 3-14. User charges would be $6.25 per month if future capacity beyond 1985 is not grant eligible and $8.40 per month if no future facilities are grant eligible. Since Alternative B does not comply with the secondary treatment requirement of PL 92-500, which is a condition for grant funding, it appears that the probable user charge would be $8.40 per month, an amount $4.85 greater than the present monthly user charge. Impact of cost would be adverse, moderate, long-term, irreversible, and definite.

If the requirements of PL 92-500 for secondary treatment are disregarded, a substantial legal fine may be levied, as indicated in the section on legal and institutional impacts.

Social, recreational and cultural. Alternative B would not fulfill goals expressed by 54 to 64 percent of the citizens interviewed (HRPI, 1976).

Recreational areas in Lake Washington, in Carkeek Park, near West Point and near Alki could be adversely affected by combined sewer overflows, wastewater treatment plants and treated effluent. In particular, bacteria exceeding bathing standards in Lake Washington and commercial shellfish standards at Puget Sound beaches would continue. Since West Point, Alki and Carkeek Park plants would not be expanded, impacts on nearby parks and recreational areas would remain as at present. For more information, see the water quality and biology sections of this document and site-specific documents.

Archeological and historical. Because information on the presence of archeological sites along the interceptor routes, near the proposed regulators or at the Kenmore pump station is not available, archeological impacts for these projects are not known. Further analysis would be recommended before final design. At treatment sites, no activity would affect archeological sites. There are no acknowledged historical sites in the vicinity of the proposed construction under Alternative B.

Health and safety. A negative impact would be associated with coliform bacteria exceeding bathing standards at Lake Washington public beaches and with consumption of shellfish from Metro area beaches.

Another highly unlikely safety hazard is accidental leakage of chemicals when they are in transport, or handled on site. Although nearly every U. S. water and wastewater treatment facility uses chemicals, there have been very few chemical-related accidents.

The health and safety problems related to sludge transport and disposal would be as probable as for any other trucks in transit.

Construction risks would be the same as for any other similar construction; they would be adverse, moderate, short-term and improbable.

Aesthetics and nuisance. Currently, many of the wastewater facilities are blocked from view either by trees or bluffs, and odor is generally not a major problem except at Alki. This situation would continue under Alternative B.

These aesthetic and nuisance impacts related to Alternative B would be adverse, minor, long-term, reversible, and definite.

Construction of the interceptors and regulator stations would cause an adverse, minor, short-term, reversible, and probable impact, especially at the Montlake regulator station, where construction would occur along a major bridge across the Ship Canal.

Secondary Impacts

The secondary impacts of Alternative B would result from expanding the Renton treatment plant, sludge disposal methods and population growth. The effects of these changes on water quality, biology, energy, natural resources and the human environment are described below.

Water Quality

Renton expansion. Under Alternative B, Renton would be expanded significantly. Average flows of 86 mgd would equal about 60% of Duwamish summer low flows. The resulting flow augmentation could help alleviate temperature problems which develop in summer, but probably would not improve oxygen levels because secondary effluent has a DO of about 2 mg/l and a BOD of about 10 mg/l. In fact, the Renton effluent could have adverse impacts at low flow periods when dissolved oxygen in the lower Duwamish reaches critical levels. The severity of this problem has been reduced in the past five years by sewage and industrial waste improvements, but a substantial increase in the Renton discharge could reverse this trend as the ammonia discharged would consume oxygen for oxidation to nitrate, further depleting oxygen levels in the river. CSO's to the Duwamish would add about 1 percent or about 3 days of Renton's projected flow of 86 mgd at 13 points.

The total solids load to the Duwamish from both CSO's and Renton would increase from 980 tons/year (1975) to 2200 tons/year over the next 30 years. Nutrients and ammonia levels could be significantly affected by the increases in Renton effluent. Metals and toxicants discharged from Renton are unknown, or are expected to be minor. Levels will remain low only so long as the undigested sludge is transferred to West Point.

The overall adverse impact from the increase in Renton discharge is expected to be significant because the flow is large relative to the Duwamish flow. Impacts would be long-term, because the increased discharge will continue through the planning period and, except for any increases in toxicant and heavy metal concentrations, reversible.

Sludge disposal. Leachate runoff at the Cedar Hills sanitary landfill would not be a problem. The soil is quite impervious, limiting groundwater flow to approximately one foot per year. The leachate waters at Cedar Hills will be collected in a system of pipes presently under construction. Runoff streams from the sludge basins visibly have good quality. Impacts at the Pack Forest site will be monitored.

Biology

Discharges of 86 mgd (average) of secondary effluent from Renton would have an effect on the toxicity, temperature, ammonia, and DO levels of the Duwamish.

Chlorine residuals (probably in the monochloramine form) could be toxic in the estuary. Studies to date (Buckley and Matsuda, 1973) indicate that 29% of the Renton effluent is toxic (TL 50 for 96 hours), primarily due to chlorine residuals of 0.2 mg/l. Under this alternative, the chlorine residual below Renton may at times exceed safe levels (0.05 to 0.01 times the chlorine residual of 0.2 mg/l, or 0.01 to 0.02 mg/l chlorine residual). At present effluent flows, migrating fish are not expected to be affected due to mitigating factors, including effluent plume avoidance by migration. Larval or juvenile fish, however, are far less able to avoid the effluent plume and thus may be exposed for longer periods. With the expansion of the facility to 86 mgd, the effluent would comprise about half of the river's summer low flow, such that fish would be exposed to levels of chlorine exceeding safe levels.

The increased freshwater flow would also change the salinity distribution, such that summer blooms may consist of freshwater rather than marine phytoplankton, and mean better flushing of the estuary. The zooplankton would probably also change, but to a lesser degree. The benthos would continue to be stressed by CSO's, low DO, and nutrient enriched sediments, although more flow could mean better dilution in summer. The net effect on the benthos of the various minor benefits and major negative impacts is major, negative, and extensive. The effect on migratory fishes would also be major, adverse, extensive, and of long duration due to constantly increased levels of ammonia, low DO, CSO's, and chlorine, discussed previously. The effect on other fishes could also be major and adverse. Waterfowl could leave if their prey species are adversely impacted. The effects are considered to be reversible.

Energy and Natural Resources

Energy and natural resources used at the Renton plant are described below.

Energy. For Alternative B, a net of 52 million equivalent kwh/year of energy would be consumed in 2005 at Renton. Included would be 49 million kwh/year of electrical energy purchased, and 3 million equivalent kwh/year required to produce the chemicals consumed. There would be no sludge trucking, nor energy consideration for anaerobic digestion. The impact of the energy consumption would be adverse, moderate in magnitude, long-term, irreversible and definite.

Chemicals. Chlorine would be the only chemical used, at an annual rate of 1020 tons. The supply of chlorine is reliable. The impact of chemical usage would be adverse, moderate, long-term, irreversible and definite.

Human Environment

Population and employment. Population distribution under Alternative B would be the same as Alternative A. For more detail on impacts attributable to growth, the reader is referred to the separate growth section of this chapter.

Operation and maintenance employment at Renton would include 41 personnel as well as related Metro staff. Construction would involve approximately 200 employees for five years.

Costs. If Alternative B is implemented, capital costs for construction at Renton would be $106,100,000, as indicated in Table 3-13. Renton operation and maintenance would cost $3,220,000 per year. The effect of this on user charge is noted in the primary impact section, since user charges are determined on a Metro-wide basis. Impact of cost would be adverse, moderate, minor, long-term, irreversible, and definite.

Mitigation Measures

Several mitigation measures are suggested to aid in the reduction of adverse impacts resulting from the implementation of this alternative.

An improved chlorine feed system can be designed to prevent chlorine levels in the Alki,Carkeek Park and Richmond Beach sewage treatment plant effluent from exceeding safe levels. This could be achieved by matching chlorine feed rates to effluent discharge and/or installing a chlorine contact tank, which would maximize the effectiveness of chlorination treatment. Currently chlorine is injected into the effluent flow at a constant rate, regardless of wastewater flow through the treatment facilities. This causes fluctuating chlorine residuals. Control of chlorine residuals at West Point could be achieved by installing a chlorine contact tank.

Flow augmentation to the Green/Duwamish Rivers during the summer months could aid in reducing the oxygen deficit of this river. Renton discharges would be equal in magnitude to the summer flows of the Duwamish River. Some augmentation is already currently provided by Hansen Dam, located on the upper reaches of the Green River.

The possible silting over of salmon spawning grounds during the construction of the Kenmore parallel (Lake Line Option) called for under Alternative B would cause impacts, both environmental and economical. Chinook lake spawning occurs in water depths of one to eight feet where there is gravel, sand, and groundwater seepage. Spawning occurs in autumn and intragravel development continues until early March. Timing construction to avoid impacts on salmon nests would restrict building activities to six months, March through August. Therefore it is recommended that an evaluation study be made on the Force Main option to determine its possible impacts. Not enough information is presently available to consider this option. If the "Lake Line" option is chosen, more detailed environmental analyses should be made of possible impacts of the pipe before construction begins.

Visual nuisance of the wastewater treatment facilities could be mitigated by landscaping to shield facilities.

Odor of the wastewater treatment facilities can be mitigated, in part, by not allowing the collection system to become anaerobic. Under anaerobic conditions, gases such as methane and noxious sulfur dioxide are emitted.

The energy impact can be in part defrayed by using more of the methane gas which is produced by anaerobic digestion. Nearly half of this methane gas is burned off under current practices. However, facilities for storing methane gas for plant or off-site uses may not be cost-effective.

The high coliforms levels at public beaches could be reduced by using the CATAD (Computer Augmented Treatment and Disposal) system to plan the discharge of combined sewer overflows at sites remote from the public beaches as a first preference.

Unavoidable Adverse Impacts

Under Alternative B (Metro Comprehensive Plan - No Action Pursuant to PL 92-500) the following adverse impacts would be unavoidable.

- Construction
- Sludge trucking
- Combined sewer overflows
- Primary effluent - effect on water quality
- Land use
- Aesthetic nuisance of plant location
- Noncompliance with Public Law 92-500
- Operation and maintenance and capital costs
- Energy expenditures

For further details on unavoidable impacts, the reader is referred to the preceding analysis.

ALTERNATIVE C - MAJOR COMBINED SEWER OVERFLOW CONTROL

The description of Alternative C and its projected impacts to the year 2005 are presented in this section.

Description

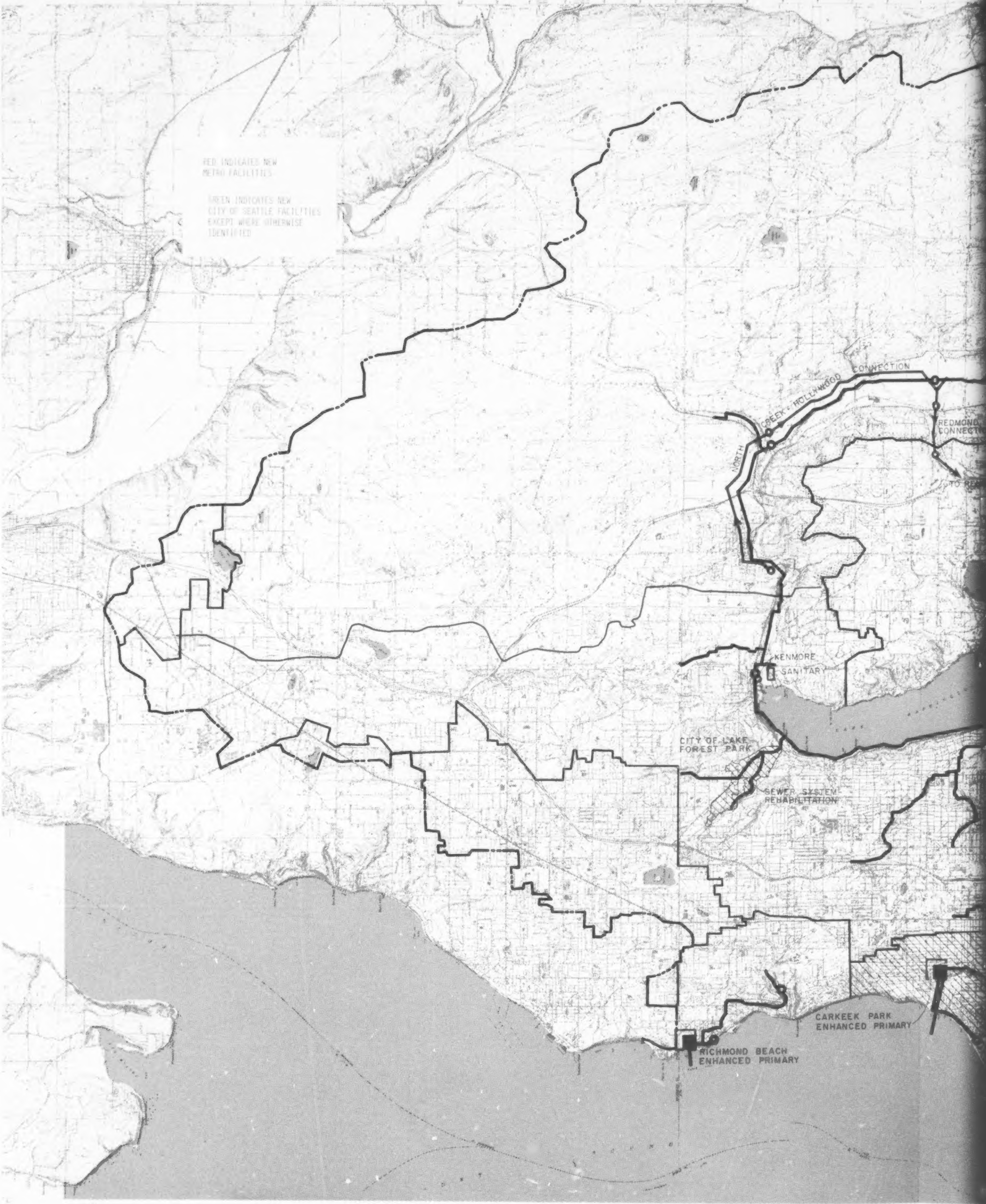
Alternative C emphasizes improving those local water quality problems that result from combined sewer overflows. This alternative would control approximately 40 percent of the CSO's (relative to Alternative B), stressing higher control levels to more sensitive inland freshwaters. CSO's to Lake Washington, Portage Bay, Lake Union and the Ship Canal would be reduced by 80 percent or more relative to Alternative B, while CSO's to Elliott Bay would increase. To achieve this level of CSO control would require construction of a major new plant in the Duwamish to treat wet weather flows.

The major wastewater facilities proposed for Alternative C are illustrated in Figure 3-10. Major features of the alternative are summarized in Table 3-18, including treatment plants, effluent discharges and combined sewer overflows, and major new transfer facilities. The construction schedule and costs for proposed facilities are shown in Table 3-19.

The alternative is further described below in terms of service area, treatment plants (location, treatment process, effluent disposal site), combined sewer overflow control and sludge management. The indirect impacts of the facilities proposed under this alternative on the Renton plant are also described.

Service Area

The service area of Alternative C would be as shown in Figure 3-1. The West Point service area would be reduced by annexing the eastern half of the North Lake Washington and North Lake Sammamish service areas to Renton by the North Creek-Hollywood connection and serving Val Vue at Renton. Growth in the west North Lake Washington area could be served by the existing Kenmore interceptor by provision of an off-line storage facility for intermittent, peak, storm-influenced flows. Provision of additional wet weather capacity in the southern West Point area would


RED INDICATES NEW
METRO FACILITIES
GREEN INDICATES NEW
CITY OF SEATTLE FACILITIES
EXCEPT WHERE OTHERWISE
IDENTIFIED
NORTH CREEK - HOLLYWOOD CONNECTION
REDMOND
CONNECTIO
TO RE
KENMORE
SANITARY
CITY OF LAKE
FOREST PARK
SEWER SYSTEM
REHABILITATION
CARKEEK PARK
ENHANCED PRIMARY
RICHMOND BEACH
ENHANCED PRIMARY

A

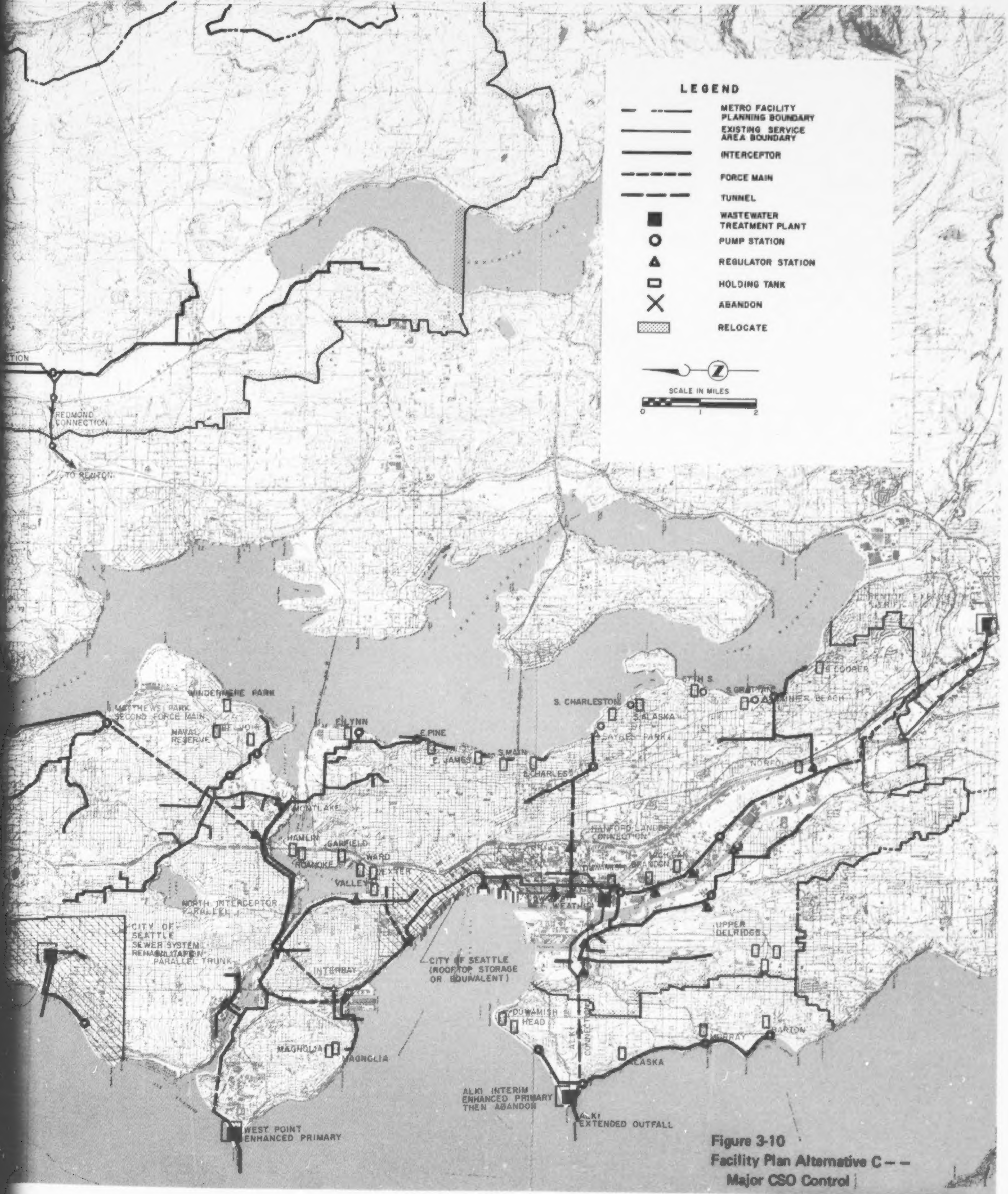

LEGEND
METRO FACILITY PLANNING BOUNDARY
EXISTING SERVICE AREA BOUNDARY
INTERCEPTOR
FORCE MAIN
TUNNEL
WASTEWATER TREATMENT PLANT
PUMP STATION
REGULATOR STATION
HOLDING TANK
ABANDON
RELOCATE
SCALE IN MILES
0
1
2
REDMOND CONNECTION
TO RENTON
WINDERMERE PARK
MATTHEWS PARK SECOND FORCE MAIN
NAVAL RESERVE
E. LYNN
E. PINE
E. JAMES
S. MAIN
S. CHARLES
S. CHARLESTON
S. ALASKA
SAYRES PARK
57TH S.
S. GRATTAN
RAINIER BEACH
S. COOPER
NORFOLK
MONTLAKE
HAMLIN
GARFIELD
ROANOKE
WARD
DEXTER
VALLEY
NORTH INTERCEPTOR PARALLEL
CITY OF SEATTLE SEWER SYSTEM REHABILITATION
PARALLEL TRUNK
INTERBAY
CITY OF SEATTLE (ROOFTOP STORAGE OR EQUIVALENT)
HANFORD LANDER CONNECTION
MICHIGAN
BRANDON
DUWAMISH
W. WEATHER
UPPER DELRIDGE
DUWAMISH HEAD
ALKI CONNECTION
MURRAY
BARTON
ALASKA
MAGNOLIA
MAGNOLIA
WEST POINT ENHANCED PRIMARY
ALKI INTERIM ENHANCED PRIMARY THEN ABANDON
ALKI EXTENDED OUTFALL

Figure 3-10
Facility Plan Alternative C — Major CSO Control

B

TABLE 3-18

ALTERNATIVE C - MAJOR CSO REDUCTION

SUMMARY

TREATMENT PLANTS

	WEST POINT	ALKI		CARKEEK PARK	RICHMOND BEACH	DUWAMISH	RENTON*
		Phase I	Phase II				
Process	Enhanced Primary	Enhanced Primary	Abandoned	Enhanced Primary	Enhanced Primary	Enhanced Primary	Secondary + Nitrification and Filtration
Improvement Completed	1985	1983	1995	1985	1981	1995	1995
Flow (mgd) in 2005 (average/peak)	139/350	10/30	0/0	3.5/20	2.5/9	0/250	99/259
Disposal	Puget Sound Existing Outfall	Puget Sound Outfall Extended	Abandoned	Puget Sound Existing Outfall	Puget Sound Existing Outfall	Duwamish	Duwamish

COMBINED SEWER OVERFLOW (2005)

	FLOW (Million Gallons/Yr)	SOLIDS (Tons/Yr)	BOD (Tons/Yr)
Lake Washington	0.19	0.17	0.05
Lake Sammamish	0	0	0
Portage Bay/Montlake Cut	35.8	32.4	8.91
Lake Union	4.14	3.76	1.03
Ship Canal /Salmon Bay	28.0	25.4	6.97
Elliott Bay	448	406	112
Alki Beach	0.15	0.14	0.04
Duwamish/Green River	186	168	46
TOTAL	702.3	635.9	175

TREATMENT PLANT DISCHARGE

	FLOW (Million Gallons/Yr)	SOLIDS (Tons/Yr)	BOD (Tons/Yr)
West Point	57,600	11,200	15,100
Alki (Phase II)	0	0	0
Carkeek Park	1,530	297	404
Richmond Beach	912	177	241
Duwamish and Renton (wet weather)	36,114	702	1,514
TOTAL	96,056	12,372	17,259

MAJOR NEW TRANSFER FACILITIES

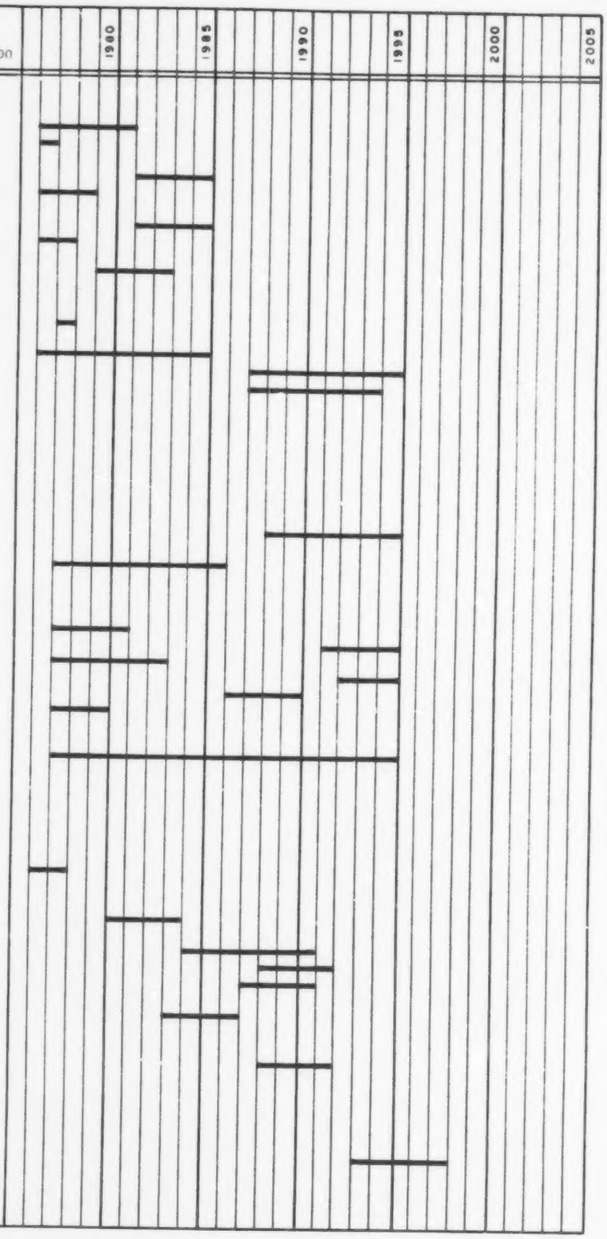
Location	Year Completed
Alki Connection to West Point and Duwamish	1995
Redmond Connection Stage I	1983
Redmond Connection Stage II	1995
North Creek-Hollywood Connection	1990
Val Vue Connection to Renton	1980

*Not included in proposed facilities plan for Puget Sound plants

Table 3-19

Alternative C -- Project Costs and Construction Staging

Facility Component	Project Cost $ Million ENR-CCI - 2600
Treatment Plants	
Richmond Beach Upgrade to Enhanced Primary Treatment	1.1
Carkeek Park - Interim Improvements	0.1
Carkeek Park - Upgrade to Enhanced Primary Treatment	1.5
West Point - Interim Improvements	4.8
West Point - Upgrade to Enhanced Primary Treatment	13.2
Alki - Interim Improvements	0.3
Alki - Upgrade to Enhanced Primary Treatment	3.3
Alki - Abandon 1996 (See Alki Connection, below)	
*Renton - Interim Improvements	0.4
*Renton - Enlargement 2 and Upgrading (Nitrification, Filtration, Sludge)	79.5
*Renton - Enlargement 3	57.0
Duwamish (wet weather)	51.0
Subtotal - Treatment Plants	212.2
Collection System	
Abandon Existing Treatment Plant Alki Connection to West Point (Dry weather) and Duwamish (Wet weather)	31.6
Rehabilitation of Existing Collection System	18.0
Increased Transfer Capacity Within West Point Existing Sewered Areas	
Kenmore P.S. (Permanent)	2.8
Holding Tank - Kenmore P.S.	5.1
Redmond Connection - Stage 1	17.0
Redmond Connection - Stage 2	3.0
North Creek - Hollywood Connection	8.0
Val Vue Connection (to Renton)	7.8
Renton - Increased Transfer Capacity and Rehabilitation within Renton Existing Sewered Areas	27.3
Subtotal - Collection	120.6
Combined Sewer Overflow Control	
Montlake Regulator Station	0.8
Lake Washington CSO Holding - 10-year Storm; Belvoir Holding Tank, Rainier Beach and Sayres Park Regulator Sta.	6.9
North Interceptor Parallel Line (1-yr storm)	73.5
Ballard Parallel Trunk (1-yr storm)	2.7
Dexter Holding Tank (1-yr storm)	3.6
Alki CSO Holding (10-yr storm; Murray, Barton and S.W. Alaska Holding Tanks)	5.8
Duwamish CSO Holding (0.1-yr storm, Norfolk, Michigan, Brandon, Diagonal Ave. Holding Tanks)	7.6
Elliott Bay CSO Holding and Transport (0.1-yr storm - Hanford-Lander Connection; Regulator stations on North Interceptor Overflow Line; S. Magnolia Ht; Modifications to Denny P.S.)	11.9
Subtotal - Hold + Transport CSO	112.8
Total Capital Cost	445.6



*Renton facilities are not part of the proposed facilities plan.

accommodate abandonment of the Alki plant. During non-storm flows, Alki sewage would be treated at West Point, and during storm flows at the new Duwamish wet weather plant. System rehabilitation work would be undertaken in the Carkeek Park and City of Lake Forest Park drainage basins to reduce excess infiltration/inflow.

The new transfer facilities that would be needed to facilitate the service area modifications would be: the Alki connection to West Point (dry weather) and Duwamish (wet weather) in 1995, the Redmond connections to Renton (1983 and 1995), the North Creek-Hollywood connection to Renton (1990), and the Val Vue connection to Renton (1980).

The construction schedule for these collection system modifications are shown in Table 3-19.

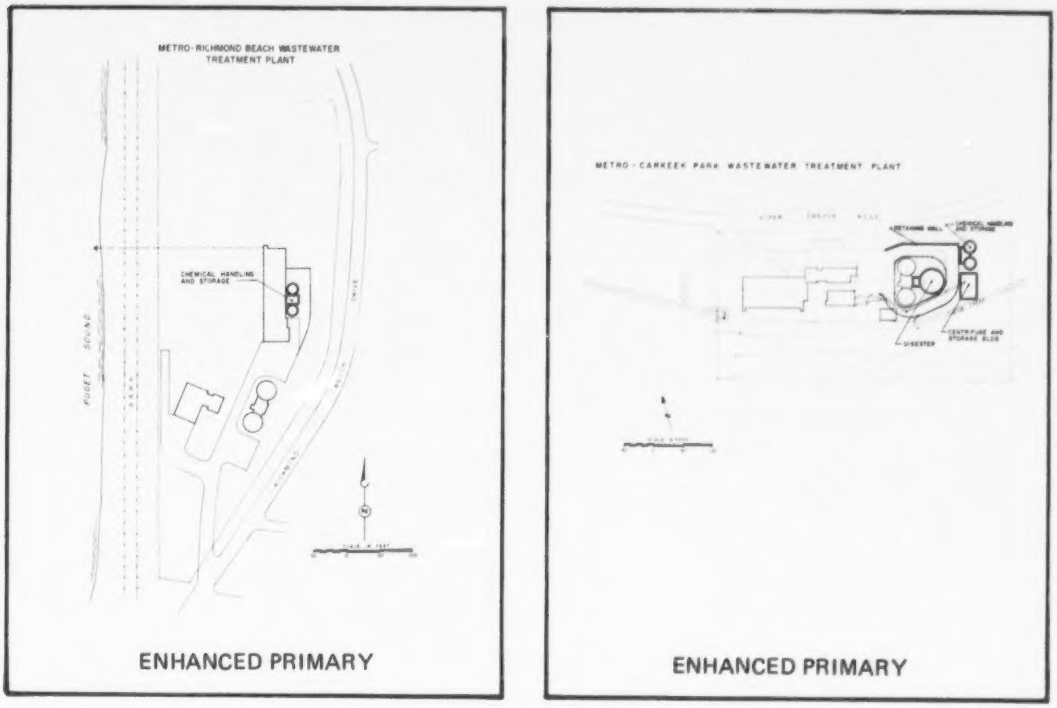
Treatment Plants

The wastewater treatment facilities under Alternative C would be as shown in Table 3-18. West Point, Carkeek Park and Richmond Beach would be upgraded to enhanced primary treatment for improved removal of suspended solids. According to the Draft Facility Plan, Richmond Beach modifications would be provided by 1981, with the other two plants modified by 1985. For the West Point, Alki, Carkeek Park and Richmond Beach facilities, the addition of chemicals for enhanced primary treatment would only occur during the summer; in other seasons, primary treatment would be provided.

A new treatment plant in the Duwamish industrial area would be completed in 1995 to treat wet weather or storm flows only; enhanced primary treatment would be used for solids removal. Projected average wet weather effluent quality from the Duwamish plant according to the facilities planning engineers would be 50 mg/l suspended solids and BOD and 700 fecal coliforms per 100 ml. With this new Duwamish facility, the Alki plant could be abandoned in 1995; interim modifications of enhanced primary treatment would begin in 1983.

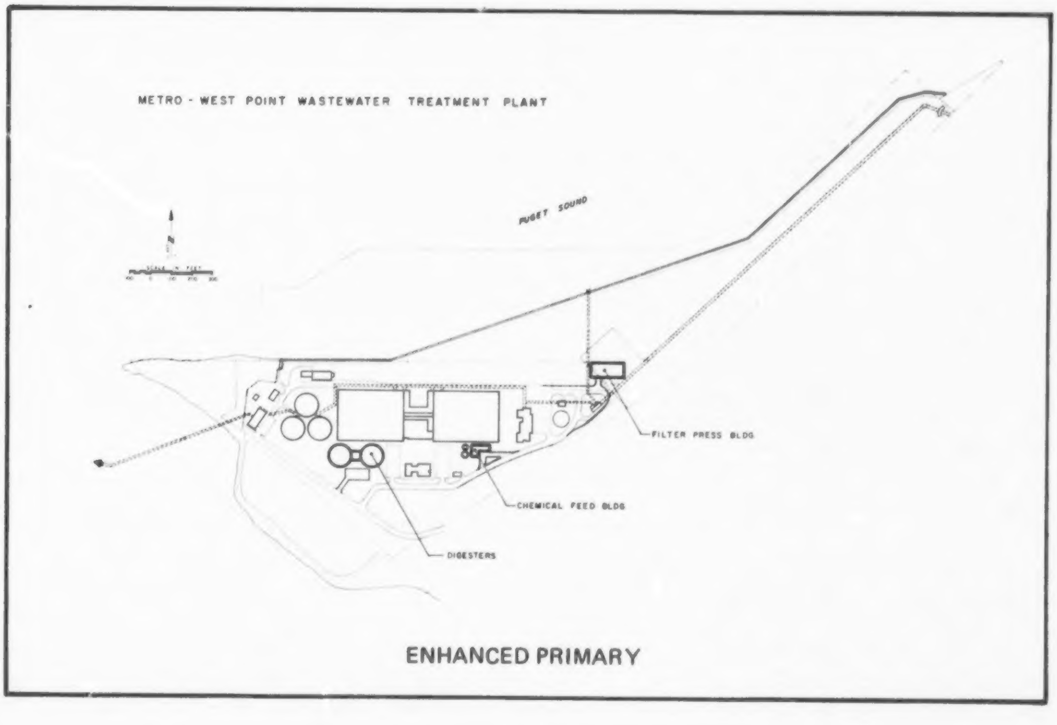
All facilities could be constructed within the existing plant boundaries. Plant layouts are shown in Figure 3-11.

The plant capacities at Carkeek Park, Richmond Beach and Alki (interim) would remain as they are under Alternative B. Some service area modifications would reduce the West Point dry weather flow slightly in comparison to Alternative B.


METRO-RICHMOND BEACH WASTEWATER TREATMENT PLANT
CHEMICAL HANDLING AND STORAGE
PUGET SOUND
SCALE IN FEET
METRO-CARKEEK PARK WASTEWATER TREATMENT PLANT
RETAINING WALL
CHEMICAL HANDLING AND STORAGE
CENTRIFUGE AND STORAGE BLDG
DIGESTER

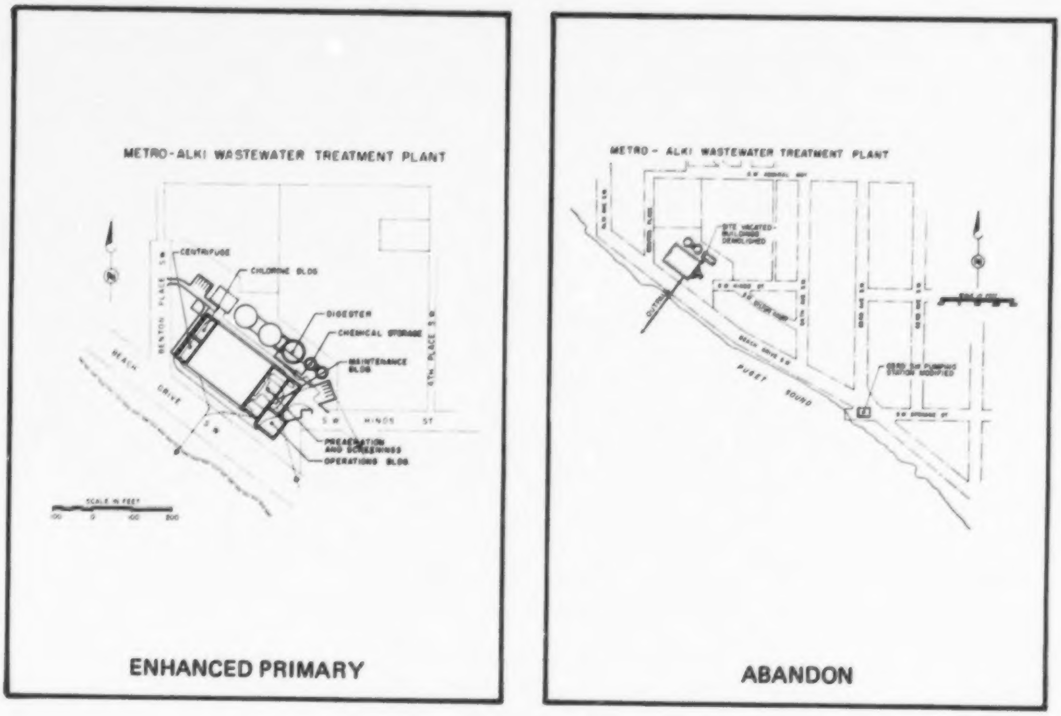
ENHANCED PRIMARY

ENHANCED PRIMARY


METRO - WEST POINT WASTEWATER TREATMENT PLANT
PUGET SOUND
SCALE IN FEET
FILTER PRESS BLDG
CHEMICAL FEED BLDG
DIGESTERS

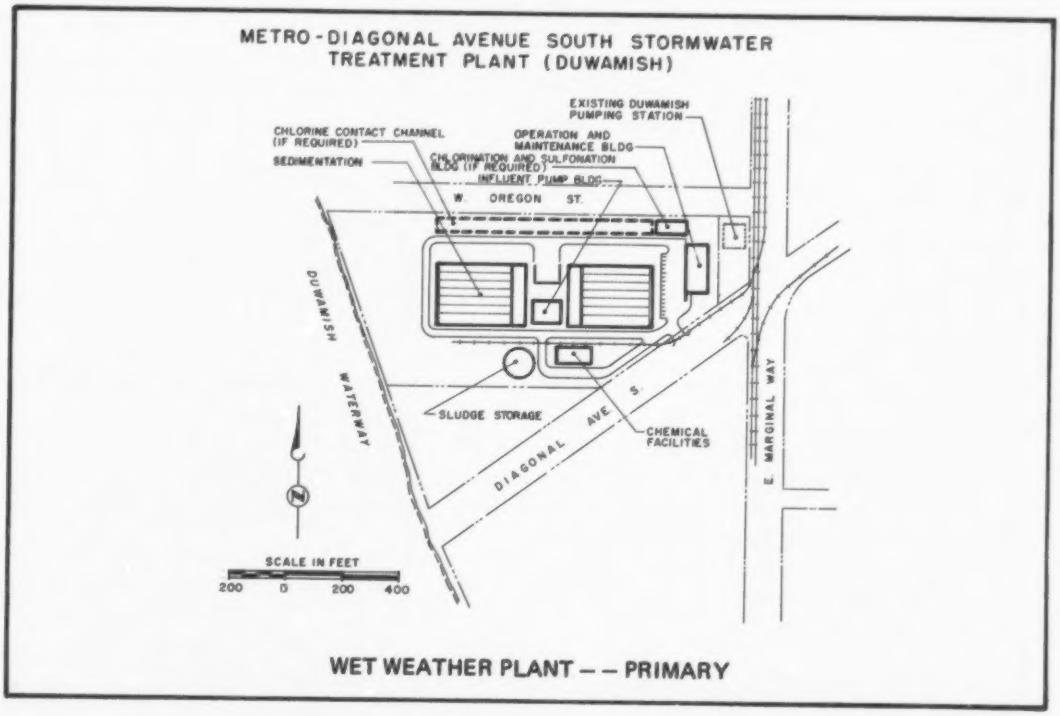
ENHANCED PRIMARY

Figure 3-11
Alternative C – – Plant Layouts, (Sheet 1)


METRO-ALKI WASTEWATER TREATMENT PLANT
CENTRIFUGE
CHLORINE BLDG
DIGESTER
CHEMICAL STORAGE
MAINTENANCE BLDG
PREAERATION AND SCREENINGS
OPERATIONS BLDG
BENTON PLACE S.W.
47th PLACE S.W.
S.W. HINDS ST
BEACH DRIVE S.W.
SCALE IN FEET
100 0 100 200
METRO - ALKI WASTEWATER TREATMENT PLANT
SITE VACATED-BUILDINGS DEMOLISHED
OUTFALL
BEACH DRIVE S.W.
PUGET SOUND
STATION MODIFIED

ENHANCED PRIMARY

ABANDON


METRO-DIAGONAL AVENUE SOUTH STORMWATER TREATMENT PLANT (DUWAMISH)
EXISTING DUWAMISH PUMPING STATION
CHLORINE CONTACT CHANNEL (IF REQUIRED)
OPERATION AND MAINTENANCE BLDG
SEDIMENTATION
CHLORINATION AND SULFONATION BLDG (IF REQUIRED)
INFLUENT PUMP BLDG
W. OREGON ST.
DUWAMISH WATERWAY
SLUDGE STORAGE
CHEMICAL FACILITIES
DIAGONAL AVE. S.
E. MARGINAL WAY
N
SCALE IN FEET
200 0 200 400

WET WEATHER PLANT — — PRIMARY

Figure 3-11
Alternative C — — Plant Layouts, (Sheet 2)

The four Puget Sound plants would continue to discharge the treated effluent through existing outfalls to Puget Sound. During the period before Alki is abandoned (1995), the existing outfall would be improved and extended.

The new Duwamish wet weather plant would discharge treated storm flows to the nearby Duwamish River. The wet weather flows would be discharged near the Duwamish plant at the junction of the East and West Waterways south of Harbor Island. The 84-inch diameter outfall would discharge at the river bottom (45 feet deep) and contain a diffuser section for a 20:1 dilution of effluent.

Combined Sewer Overflow Control

In Alternative C, combined sewer overflows would be controlled to a greater degree than in any other alternative. Overall, a 40 percent reduction in combined sewer overflows to all water bodies would result. This alternative concentrates on controlling overflows to the inland freshwater, believed to be more sensitive than the saltwater of Puget Sound or Elliott Bay. Table 3-18 summarizes the CSO's that would remain under Alternative C.

Overflows to Lake Washington and the West Seattle shoreline (Alki Beach) would be controlled to one overflow event every ten years, Lake Union-Ship Canal to one overflow event per year, and the Duwamish and Elliott Bay to ten overflows per year. This would be achieved by construction of both city and Metro storage and transport capacity, and Metro treatment capacity by construction of a 250 mgd wet weather plant in the lower Duwamish. Combined sewer holding and transport would be staged through 1996 with priority assigned according to receiving water sensitivity.

The 19 proposed collection system projects to control combined sewer overflow are summarized in Table 3-19, detailed in Table 3-20, and generally mapped in Figure 3-10. Projects include pumping stations, holding tanks, trunk lines and regulator stations. Information on exact sites is not available in the Draft Facility Plan. The engineers have indicated installations would be underground and adjacent to existing regulators in parking lots, empty lots and existing right-of-way.

Combined sewer overflows from some of the northern West Point service areas would be transferred from inland freshwaters through the North interceptor to Elliott Bay. A new outfall, 11 feet in diameter and 1200 feet long, would

TABLE 3-20

Collection System Projects to Hold and Transport Combined Sewer Overflows

	Alternative Facility Plan							
Component Project	A	B	C	D	E	F	G	H
East Marginal Way pump station and upstream:								
1. Rainier Beach regulator station			X	X				
2. South Norfolk Street holding tank			X					
Rainier-Hanford system;								
3. Sayres Park regulator station			X	X				
4. Hanford-Lander connection to Duwamish plant, sized for combined sewer overflow			X					
Other Duwamish river points:								
5. Michigan Street holding tank			X					
6. Brandon Street holding tank			X					
7. Diagonal Avenue holding tank			X					
Alki area:								
8. Murray Avenue holding tank, 0.1-year storm				X				
9. Murray Avenue holding tank, 10-year storm			X					
10. Barton holding tank			X					

Table 3-20 (continued)

Component Project	Alternative Facility Plan							
	A	B	C	D	E	F	G	H
11. S. W. Alaska holding tank			X					
Laurelhurst trunk:								
12. Belvoir holding tank, 1-year storm				X				
13. Belvoir holding tank, 10-year storm			X					
Upper Lake Washington trunk (Montlake system):								
14. East Lee Street pump station, sized for combined sewer overflow			X	X				
Lake Union, Portage Bay, and Salmon Bay:								
15. Montlake regulator station	X	X	X	X	X	X	X	X
16. North interceptor parallel line, 0.1-year storm, including inlet structures and outfall to Elliott Bay				X				
17. As above, except 1-year storm			X					
18. Dexter holding tank, 0.1-year storm				X				
19. Dexter holding tank, 1-year storm			X					
20. Third Avenue West regulator station		X			X	X	X	X
21. Ballard parallel trunk			X					

Table 3-20 (continued)

Component Project	A	B	C	D	E	F	G	H
Elliott Bay:								
22. Denny Way regulator station modifications			X					
23. Regulator stations on North interceptor parallel			X					
24. South Magnolia holding tank			X					

be constructed to discharge at a 50-foot depth west of Terminal 91 near the Interbay area, as indicated in Figure 3-10. Peak flows of 161 mgd could be discharged; no treatment would be provided for these wet weather combined sewer flows to Elliott Bay.

Sludge Management

West Point would continue as the major regional sludge processing center under Alternative C. However, sludge presently digested at West Point from Renton would be treated and processed at Renton. Richmond Beach digested sludge would be trucked to West Point, and Duwamish sludge would be sent to West Point by the Elliott Bay interceptor after each storm. The solids processing facilities at West Point and Alki would be expanded as required to handle the additional solids loads from enhanced primary treatment and increasing flows. All sludge would be processed by anaerobic digestion; the product, methane gas, would be used to the extent possible at the plant sites. The interim sludge disposal sites would be at the Cedar Hills landfill and the Pack Forest experimental site.

Renton

Although the Renton service area and treatment plant are not included in the proposed facilities for Alternative C, the alternative would have indirect impacts on the Renton plant. The Renton plant would be enlarged in two stages, completed in 1985 and 1995, to an ultimate capacity of 99 mgd average, 259 mgd peak. Because treated effluent would be discharged to the Duwamish, the need for improved waste treatment has been recognized. Future facilities would include secondary treatment plus nitrification (to convert nitrogen-containing compounds to nitrates) and filtration (to reduce effluent suspended solids). Renton sludge would be processed at Renton by anaerobic digestion.

Primary Impacts

The direct impacts from this alternative for the Puget Sound plants are described below in terms of effects on geology, soils and topography; air quality and odors; water quality; biology; energy and natural resources and the human environment. Indirect impacts from this alternative and the effects of Renton discharge are summarized under a later section on secondary impacts.

Geology, Soils and Topography

Alternative C involves the construction of a Duwamish plant, and combined sewer overflow control projects, conversion of Alki to a pump station, and chemical precipitatio of effluents, with resulting increases in sludge production. Construction impacts on land resources are discussed in the accompanying site documents.

Earthquake damage risk would continue at existing sites and be correlated with physical factors at new sites as expressed in more detail in Chapter II. Holding tanks constructed in lowland areas, for which sites are undetermined, probably have potentially high earthquake damage risk and would need to be constructed with that in mind. These tanks may also permanently affect wetland and shoreline areas and shore protection structures.

Impacts would continue at existing sludge disposal sites. All alternatives include the interim disposal site at Cedar Hills which with the loadings under this alternative would last 30 years under current practices or under Alternative C. Impacts would be monitored at the Pack Forest Sludge disposal site. Other potential disposal sites have been identified by the facilities planning engineers, but no decision is anticipated in the Facility Plan.

Construction waste disposal may cause limited but long-term effects on the site chosen. The impact is set by judgment as no sites have been identified and the magnitude of the impact is a function of site. It is expected to be minor, however.

For the nineteen collection system projects for CSO control, most effects on land resources would be due to excavation: disturbance of soil profiles, temporarily increased erosion and deposition, and potential problems at construction waste sites due to disposal of excavated materials. The new facilities would be subject to a minor risk of earthquake damage as are all structures in the study area.

The North interceptor parallel and the Ballard parallel trunk would, in addition, cross the Ship Canal upstream of the locks about three miles and 1.5 miles east of Shilshole Bay, respectively. Construction would disturb bottom sediments over a limited area for a short time (about six months). The impacts are considered to be reversible on geology, soils and topography.

Irreversible impacts would result from the construction of a tunnel more than a mile long and 11 feet in diameter under the northwest portion of Queen Anne Hill from the Ship Canal to the Interbay station. Disposal of about 27,000 cubic yards of excavated material could have major impacts on disposal sites chosen.

Construction of the outfall to Elliott Bay from the North interceptor would require dredging of bottom sediments, which would be replaced as backfill and covered with riprap to minimize erosion by currents. Construction would temporarily disturb sediments; rock riprap would permanently change the local character of the bottom.

Air Quality and Odors

The trucking of sludge to West Point and from West Point, Carkeek Park, and Renton to the Cedar Hills landfill would emit approximately 440 grams of hydrocarbons, 2755 grams of carbon monoxide, and 2010 grams of nitrogen oxides per day. Treatment plant personnel traffic would emit about 4790 grams of hydrocarbons, 60,935 grams of carbon monoxide, and 7895 grams of nitrogen oxides per day. The combined emissions would amount to less than 0.01 percent of Seattle's total daily emissions of hydrocarbons, carbon monoxide and nitrogen oxides. The air pollutants emitted under this alternative would have a negligible, long-term, adverse, reversible impact on the air quality of the Seattle area. Use of the Pack Forest research site would increase emissions but the impact would still be negligible.

Upgrading the Richmond Beach, Carkeek Park, West Point and Alki plants to enhanced primary treatment would not noticeably increase the potential for odor problems in these areas. The construction of a new enhanced primary treatment plant in Duwamish in 1995 would increase the liklihood of odors escaping in this area. The abandonment of the Alki plant in 1995 would eliminate the potential for odor problems there. The substantial reduction in CSO's to Lake Washington, Portage Bay, Lake Union, the Ship Canal and Elliott Bay would significantly reduce the occurrence of odors arising from CSO's in these areas.

The construction of the collection system projects listed in Table 3-20 and mapped in Figure 3-10 would result in temporary, localized increases in particulates (dust) and in engine emissions (exhaust fumes). These problems will be intensified for projects in the Duwamish Valley (Norfolk, Michigan, Brandon, Diagonal Way, Hanford-Lander Connection) and in the Interbay Valley (North interceptor parallel including outfall) where air circulation can be restricted and trap air pollutants. Air pollution potential would be smallest at Magnolia and West Seattle where air mixing is good. Some odor would be expected if existing sewer lines were opened in summer months.

The overall potential odor problems associated with this alternative would have a minor, long-term, adverse, reversible impact on the environmental quality of the Seattle area.

Water Quality

Alternative C provides for upgrading the West Point, Alki (interim improvement), Carkeek Park and Richmond Beach plants to enhanced primary treatment and constructing a new wet weather enhanced primary plant in the Duwamish area. The most significant improvements in water quality under this alternative, however, would result from the substantial reduction of CSO's to inland waters.

Construction of combined sewer overflow holding and transport systems listed in Table 3-20 and mapped in Figure 3-10 result in long-term benefits to some freshwaters as discussed below but short-term adverse impacts on water quality would also follow.

Erosion of excavated materials would increase runoff turbidity, probably increasing turbidity in receiving waters. The effect, however, could be the same or less negative than from existing overflows. The reversible effect is judged to be negligible-to-minor over baseline conditions, limited in extent and short-term.

Lake Washington. A 99% reduction (relative to Alternative B) in CSO's to Lake Washington would be significant and have long-term, beneficial impacts on Lake Washington water quality, especially in nearshore waters where mixing and dilution are limited. Overflows to Lake Washington would be limited to once in 10 years. Sanitary water quality would improve; the potential for coliform bacteria exceeding bathing standards near overflow points would probably be eliminated. While overall pollutant loads to

Lake Washington from CSO's are uncertain and unknown relative to other sources, the improvement could be significant on a local basis. Lake Washington nearshore areas are considered sensitive waters with DO lower than "natural". Some of this is partially due to the Sammamish River, which drains into Lake Washington, and is subject to frequent coliform violations, high nutrient concentrations, and temperature violations. Overall, impacts would be beneficial, limited in extent, and long-term.

Lake Union/Ship Canal. CSO control under Alternative C would mean a substantial reduction (relative to Alternative B) in flow, BOD and solids loadings of 93 percent to Lake Union and 89 percent to the Ship Canal/Salmon Bay. Overflows to Lake Union would be limited to once per year. Lake Union/ Ship Canal is considered a sensitive water body subject to water quality violations, which are currently occasional-to-frequent in occurrence. The benefit of nearly complete CSO control on water quality is expected to be minor, because the water would still be dregraded by other sources, but extensive in this water body. Benefits would be long-term, because the reduction in CSO's would continue through the planning period.

Excavation in the Ship Canal would also generate turbidity due to sediment excavation. At the same time, however, metals, toxicants and perhaps pathogens in the sediments would possibly reenter the water column and become available for biologic uptake by free-swimming organisms. The possible adverse impact is considered to be minor and limited in extent.

Duwamish Estuary. Pollutant loadings of CSO's to the Duwamish would be reduced 26% for annual flow volume and tons BOD and solids. CSO's presently contribute annually about 12% of Renton's daily flow (1975 data) or about 43 days' flow. With the expansion of Renton, the reduced levels of CSO's will constitute less than 1% or about three days of Renton's average daily flow. Overflows would be limited to ten events per year. The beneficial effects from the control of CSO's would be significant, because the pollutant flow is substantially reduced; extensive, because the reduction in CSO's would benefit Elliott Bay as well as the Duwamish estuary; and long-term because the reduction will continue through the planning period.

Duwamish overflow control may be significant for parameters such as metals, oil and grease, pesticides and PCB's which are long-term pollutants that affect freshwater and estuarine life when present in exceedingly low concentrations. The beneficial effects of CSO control could be overshadowed, however, by the serious, adverse effects of the Renton expansion.

The Duwamish wet weather facility proposed in Alternative C would discharge up to 250 mgd (387 cfs) of chlorinated primary effluent at a depth of 45 feet to the Duwamish estuary just south of Harbor Island. The effluent from this major new point source is expected to contain approximately 50 mg/l each of BOD and suspended solids and have a fecal coliform MPN of 700/100 ml plus undetermined concentrations of nutrients, metals and other parameters (Metropolitan Engineers, 1977). A diffuser section is expected to provide a 20:1 dilution of the effluent.

The effluent would probably rise to a level of neutral buoyancy based on salinity and/or surface. Neutral buoyancy could be at the interface between the salt wedge and overlying fresh waters of the estuary. The effluent, characterized by low dissolved oxygen and about 2.5 mg/l BOD after dilution, could further reduce oxygen levels in estuarine waters. Based on limited combined sewer overflow quality data (Metro staff, 1976; Metropolitan Engineers, 1977) the effluent could contain about 1.5 mg/l total phosphorus, 0.5 mg/l nitrates and 1 mg/l ammonia. Disinfection at the facility could introduce potentially toxic chlorine residuals to the receiving waters.

Puget Sound. Alternative C would result in essentially a continuation of present treated wastewater loads to Puget Sound. Localized changes would be attributed to combined sewer overflows.

For the Sound as a whole, Alternative C would contain increased wastewater treatment plant flows, relative to existing conditions, but total loads of solids and BOD would remain at present levels due to improved removal processes in enhanced primary treatment. For comparison, the combined West Point, Alki, Carkeek Park and Richmond Beach plants discharged 48,000 million gallons of primary effluent in 1975, which contained approximately 20,000 tons of suspended solids and 16,000 tons of BOD. Projections for 2005 under Alternative C would be approximately 60,000 million gallons, but the suspended solids and BOD would remain at approximately 12,000 and 16,000 tons per year respectively. Compared to Alternative B, wastewater flows, solids and BOD to Puget Sound would decrease by approximately 4, 25 and 24 percent, respectively, under Alternative C.

Thus, the regional water quality impacts to Puget Sound from wastewater treatment plant discharge should be similar to existing conditions (described in Chapter II) or to Alternative A. Small localized decreases in dissolved oxygen, plus minor increases in turbidity, nutrients, and toxicants should continue near the outfalls or in areas near beaches where diluted effluent could be dispersed. Slight improvements in these factors relative to the baseline Alternative B should result as indicated by decreases in wastewater flows and loads. During seasons other than summer (when enhanced primary treatment would be provided) discharge of primary effluent would continue and could affect local areas to a minor degree near outfalls.

At Alki, combined sewer overflows would be virtually eliminated and the plant abandoned in 1995. In the interim, improvements to the outfall would be beneficial, as described under Alternative B. Control of the combined sewer overflows near Alki would remove one source of nutrients, suspended solids and bacteria, that could be affecting the local beach. It is likely that bacterial water quality would improve in Alki shell-fishing areas with curtailment of CSO's and improvements in the outfall.

Other changes would occur in Elliott Bay, where combined sewer overflows would increase to 448 million gallons per year (compared to 358 million gallons per year under either Alternative B or existing conditions). Corresponding increases in nutrients, toxicants, bacteria, suspended solids, BOD and other parameters would occur during and following storms. Although the facilities planning engineers have indicated the outfall from the Interbay area to Elliott Bay will achieve a storm water dilution of approximately 100:1, preliminary independent calculations indicate that the projection is optimistic. Therefore, the estimated impact on local water quality near the outfall would be adverse, minor, long-term, limited and reversible (except for some metals and toxicants which could accumulate). Pathogens could increase in waters of Elliott Bay and along West Point's south beach, as the unchlorinated effluent would be carried in that direction by net water circulation. The effluent would also tend to surface along shores due to the shallow discharge depth.

Other freshwaters. Alternative C would not directly affect Lake Sammamish, Cedar River, Green River or Sammamish River water quality.

Groundwater. The effluent from each of the treatment plants, except Duwamish, would be discharged into Puget Sound and would be incapable of infiltrating groundwater. Impacts of sludge disposal at Cedar Hills and Pack Forest would be monitored.

Flood hazard. Floods are not expected to cause problems at any of the treatment plants because each of the sites is above the 100 year flood zone.

Biology

Discharge of up to 250 mgd of wet weather primary effluent to Elliott Bay would stress resident biota, although the discharge would be diluted. Major CSO control would relieve pressures on biota in the Duwamish, Lake Union/Ship Canal, at Alki, and Lake Washington. Transfers of CSO's from inland waters would increase CSO's to Elliott Bay. Pathogens in shellfish at Alki would be substantially reduced probably due to CSO reduction and extension of the Alki outfall. Wastewater treatment plant loads to Puget Sound would have essentially the same impacts as under existing conditions, which would be an improvement relative to Alternative B.

Terrestrial habitats. The effects on regional terrestrial habitats are expected to be negligible, as new facilities would be in urban areas. Site impacts for the Duwamish plant are discussed in the Alki document which is Volume II of this series.

The construction of the collection system projects to hold and transport combined sewer overflows listed in Table 3-20 and generally mapped in Figure 3-10 are expected to impact terrestrial ecology minimally as holding tanks and regulators would be built under already paved-over or other highly disturbed areas. Construction noise and vibrations, however, would temporarily frighten away birds and mammals from construction sites in residential areas.

Shoreline habitats. Since overflows would be reduced approximately 99 percent to Lake Washington, 90 percent to Lake Union/Ship Canal, and 26% to the Duwamish (from 1975 and Alternative B levels), loadings of solids, BOD, pathogens, metals, ammonia, nutrients, and toxicants would be greatly reduced. The benefit to the shoreline areas of Lake Washington and the Ship Canal would probably be moderate-to-major, and long-term. The effects of former inputs of metals and toxicants are irreversible, but loadings of these chemicals would stabilize.

The intertidal. Elements of Alternative C affecting the intertidal area are a reduction in CSO's at Alki, increased effluent discharges from the Metro outfalls until 1995, when Alki is abandoned; upgrading of effluents to enhanced primary treatment levels, and improvement of the Alki outfall then abandonment in 1995.

CSO's to Alki/West Seattle beaches would be almost eliminated, very probably reducing the amount of metals, solids, BOD, nutrients, oil, grease, pathogens, and toxicants impringing on biota and available for uptake and concentration. Limited data available (at Denny Way) on effects of CSO to saltwaters indicate adverse effects are moderate-to-severe, limited in extent, of long duration and probably irreversible for metals, toxicants. The potential benefit of reduction of CSO's would be moderate, also limited and long-term. Metals and toxicants levels would stabilize in biota in time, and the intertidal communities could gain in abundance and diversity at the outfall points.

For impacts of treatment plants on the intertidal, upgrading to enhanced primary treatment would reduce BOD, solids, metals and phosphates concentrations in effluent. The levels of nitrates would be as at present, however, and it is these nutrients that can become limiting in the Sound. Assuming effluent from all plants enters the intertidal occasionally, the potential enrichment effect of effluents would continue and increase, except at Alki where effects would be reduced or eliminated with improvements and eventual abandonment of the outfall.

Since chlorination facilities would operate under present conditions with no upgrading, overchlorination and underchlorination would be common. Underchlorination would probably maintain fecal coliform levels in excess of state shellfish standards, and overchlorination could produce chlorine residues toxic to intertidal and eelgrass bed organisms. When Alki is abandoned, these effects would be eliminated. With respect to solids, oil, grease, and toxicants, Alternative C would result in a moderate benefit to the intertidal. With respect to potential chlorine toxicants, nutrients, metals and pathogens, there would be little change in or even an increase over present levels of impact except, eventually, at Alki.

Puget Sound. Effects on nearshore and offshore waters from Alternative C would be from increased effluent flows and some pollutant loads, the extension and abandonment of the Alki outfall, the effects of additional CSO discharge to Elliott Bay, and continuation of chlorination practices. Nutrient loads would increase, with a similar increase in potential over-enrichment problems.

Offshore phytoplankton and zooplankton would continue to be affected by nutrients in dispersing effluent plumes, such that productivity extremes would continue to be affected. The extended Alki outfall would place the effluent closer to mid-channel where major algae blooms develop. It is not known whether or not any new effects would occur as a result. The effect is considered to be adverse, moderate, reversible, limited in extent and of long duration.

The distribution of some nearshore and offshore benthic organisms, which does appear to be correlated with characteristic plume positions for West Point and Carkeek effluents, would be maintained. Although enhanced primary does remove solids and BOD, the loading would remain at 1975 levels with the increase in flows.

Offshore and nearshore free-swimming organisms may continue to be occasionally affected if they swim into or through an effluent patch, or if they feed in nearshore areas at night. The effect is considered to be minor, limited in extent to plume areas, and of short duration, as overchlorination is short-term but continuing.

The composition, diversity and abundance of fishes off the outfalls would probably change little as overall loads to the Sound through the outfalls would remain approximately at existing levels. The evidence of tumorous flatfish at West Point, to the extent the effluent and perhaps the pipe itself are involved, would probably not change. The effect is considered to remain adverse, major, limited in extent to outfall areas, of long duration and probably reversible.

With the abandonment of the Alki outfall, the effects of this point source would be eliminated, probably with benefits to the benthic nearshore and offshore environments. The pipe itself would continue to be attractive to fish that feed on attached animals. Any metals or toxicants in these organisms would probably remain.

Effects on intertidal and nearshore biota could be substantial from a large point source of up to 161 mgd of untreated combined sewer effluent discharged to Elliott Bay. Effects are considered to be major, but limited in extent, of long duration as flows are intermittent but continuing, and irreversible for metals and toxicants.

Commercial and sport fisheries. Reducing sewer overflows to Lake Washington, Lake Union/Ship Canal, and to the Duwamish would improve the quality of these waters which are important migration, spawning and rearing areas to migrating salmonids. Reducing CSO's to Alki/West Seattle would benefit herring fishing associated with those areas. In contrast, increasing CSO's to Elliott Bay could affect fish migration areas.

The Duwamish estuary. Sewer overflows would be reduced under Alternative C by about one-third. At the same time, the Renton plant would be greatly expanded. As the overflows would be 0.5% or the equivalent of about two days of Renton's flow, the facility's effects are considered to be more important overall. The Renton plant is discussed in a subsequent section on secondary impacts. The effects of the CSO control alone are considered to be a minor, long-term benefit to limited areas of the estuary ecological community.

A new Duwamish wet weather plant would discharge up to 250 mgd of chlorinated primary effluent to the Duwamish estuary south of Harbor Island. While effects on biota have not been predicted, in being characterized by low DO and a BOD of 2.5 mg/l after dilution, the effluent could possibly affect the DO levels and thus the biota in the lower estuary. Coho and chum salmon, and winter steelhead and searun cutthroat trout migrate upstream in the wet season in the Green-Duwamish Basin (November through April) and could be affected by effluent's depression of DO or by residual chlorine. Resident fishes could be similarly affected. The effluent would probably not affect algal productivity to a great extent as blooms occur in summer when effluent flows would be insignificant. Further study of effluent dispersal, currents and biota would be required to outline more specifically the effluent's effects on the biota of the lower Duwamish estuary.

Freshwater environments. CSO control under Alternative C would be a major benefit to freshwater environments. No Kenmore Parallel is planned under this alternative, so construction would not affect shoreline areas.

1. Lake Washington. An almost complete reduction of CSO's to this lake would mean a major, long-term benefit to limited areas of the western shore of the lake, including

slamon spawning areas and perhaps bathing beaches which record high bacterial counts after a storm overflow. Offshore organisms, which are affected less by overflows, would in turn be benefited less by CSO control. Metals and toxicants already in the lake would continue to affect the shoreline biota, however.

2. Lake Union/Ship Canal. The magnitude of the impacts of overflows on the biota in this water are unknown. Of the observed problems, the amount that can be attributed to overflows has not been determined. A reduction would clearly be a benefit, but of undeterminable magnitude. As this water is an important salmonid migration route, major overflow reductions are considered to have a moderate positive impact, extensive in the water body, and of long duration.

The Ballard parallel trunk and the North interceptor parallel would be constructed across the Ship Canal. Construction would last approximately six months. The Ship Canal is a critical waterway for the migration of salmon and trout of the Lake Washington drainage. Fish susceptibility to natural mortality and predation for the period of construction could increase due to excavation of the bottom, physical obstacles, noise, turbidity, and possible resuspension of toxic elements in the sediment. The effect is considered to be potentially substanial, but highly limited in extent and probably of short duration and reversible except for toxic elements.

Operation of these lines, however, would decrease CSO's to the Ship Canal and the western shore of Lake Washington, thereby reducing water-quality induced stresses on migrating and spawning slamonids in the long run.

Other freshwaters. No direct biological impacts are projected.

Rare and endangered species. No impacts are expected as no listed endangered species are recorded from the study area. Critical habitats, which include salmon spawning and rearing areas, fish migration routes, waterfowl resting areas, and lake shallows have been discussed in previous sections.

Energy and Natural Resources

Energy. For Alternative C, a net of approximately 36 million equivalent kwh/year of energy would be consumed in 2005 by the Puget Sound plants. Included in this would be 29 million kwh/year of electrical energy purchased. This is equivalent to the amount of electrical energy 1450 households would consume per year, and constitutes approximately 0.15 of the projected electrical energy consumption of Seattle in 2005 (Appendix E).

Table 3-21 shows the breakdown of total energy consumption on a plant-by-plant basis. The greatest energy consomption would be in the form of electricity. Chemicals would account for about 10-30 percent of energy consumption, and sludge trucking for 5-30 percent. In the anaerobic digestion of sludge, there is a net production of energy because of methane formation; about half of the methane would be flared off and the remainder would be used at the plants.

The impact of the energy consumption would be adverse, moderate in magnitude, long-term, irreversible and definite.

Chemicals. Annual chemical consumption under Alternative C would be 2045 tons of chlorine, 41.5 tons polymer, 5610 tons lime, 7430 tons alum and 575 tons ferric chloride per year, shown in Table 3-21. The supply of chlorine, alum and polymer is highly reliable. Lime and ferric chloride are in moderate supply (HRPI, 1976). The impact of chemical usage would be adverse, long-term, irreversible and definite.

Human Environment

Alternative C would cause a 40 percent decrease in combined sewer overflows, enhancing the quality, healthfulness, and overall aesthetics of the Metro area freshwaters. However, this alternative does not comply with PL 92-500.

Land use. A number of parcels of land would have to be made accessible for holding tanks, regulators and interceptors. Land use would in general not change at the treatment plant sites with the installation of advanced primary treatment facilities because no new land would be required. Alki's abandonment in 1995 would create the potential for increased recreational land if the buildings are demolished and the area landscaped. Such changes are optional and not costed into the alternative, however.

Interceptors, holding tanks and regulators may be installed underground, and would therefore have no impact

TABLE 3-21

ENERGY AND CHEMICAL CONSUMPTION FOR ALTERNATIVE C

	PLANT					
	Richmond Beach	Carkeek Park	West Point	Alki	Duwamish	Total
ENERGY CONSUMPTION						
Onsite Energy						
Purchased electricity (kwh x 10^6/yr)	0.66	1.05	25.67	1.36	0.46	29.20
Produced by digestion (kwh x 10^6/yr)	0.36	0.62	16.64	-	-	17.62
Consumed by digestion (kwh x 10^6/yr)	0.14	0.25	6.66	-	-	7.05
Offsite Energy						
Chemicals (kwh x 10^6/yr)	0.16	0.33	15.20	-	0.04	15.73
Sludge Trucking (kwh x 10^6/yr)	0.12	0.03	1.31	-	0.04	1.50
TOTAL	0.72	1.04	32.20	1.36	0.54	35.86
CHEMICAL CONSUMPTION (tons per year)						
Chlorine	35	60	2140	0	10	2245
Polymer	0.6	5.2	35	0	0.7	41.5
Lime	40	70	5500	0	0	5610
Alum	135	240	7055	0	10	7430
Ferric Chloride	0	0	575	0	0	575

on land use once construction is complete. Construction impacts experienced vary with the existing land use, however. In the primarily industrial Duwamish area, the new Duwamish wet weather facilitiy would probably be located at the Diagonal Way site, which was once the site of a wastewater treatment facility, since abandoned. The Norfolk holding tank Duwamish holding tank, Hanford-Lander Connection and most of the Alki-Duwamish connection would also be built in the Duwamish industrial areas where most construction impacts on land use would be less important than in residential areas. Other projects in industrial-commercial areas include the Ballard parallel trunk, portions of the Interbay outfall line and the Dexter holding tank.

Residential or park areas would be affected by the Barton, Murray, and Alaska holding tanks in West Seattle, plus construction at the Alki facility, the Alki-Duwamish connection, the North interceptor parallel, the Rainier Beach and Sayres Park regulator stations along Lake Washington, and the Belvoir holding tank near Union Bay. The Kenmore holding tank and pump station on Lake Washington and the Magnolia holding tank would also be constructed in residential or park-like areas. A number of these projects could also require Shoreline Management Permits if within 200 feet of shores, including the North interceptor parallel, the Ballard parallel trunk, the Montlake regulator, the Alki-Duwamish connection and some of the holding tanks and regulators.

2. Legal and institutional. Alternative C does not comply with PL 92-500 nor the Washington NPDES Regulations, which require secondary treatment. A fine as high as $10,000 per day could be levied against Metro for noncompliance, as explained in Chapter II. This impact would be adverse, major, long-term, and probable.

The Shorelines Management Regulations would be applicable as stated above. The likelihood of meeting bacterial standards for swimming in Lake Washington would be increased with CSO reduction. Probably no U.S. Corp of Engineers permits would be required.

Agency goals. Alternative C was originally established to address Metro's best practicable treatment (BPT) goal of identifying and solving water quality problems in the Metro service area. In relation to Alternative B, Alternative C reduces combined sewer overflows by approximately 40% overall to Lake Washington, Portage Bay/Montlake Cut, Lake Union, Ship Canal/Salmon Bay, Alki Beach and the Duwamish. Solids and BOD loads from West Point, Alki, Carkeek Park and Richmond Beach would be reduced by 25 and 24 percent, respectively, compared to Alternative B. For impacts on water quality, see the discussion in that section.

It is speculative whether this alternative fulfills the objectives of Goals for Seattle, which states, "the city should undertake efforts to meet Federal Water Pollution Control Act requirements by 1984." This alternative alleviates the frequent odor problem at Alki after 1995, which (in addition to affecting the Alki residents directly) fulfills the PSCOG goal of "maintaining the natural beauty and liveability of the region."

Employment. There would be approximately 400 employees for 5 years required for the construction involved in Alternative C. Operation and management employment would require a total of 96 employees at West Point, Alki, Richmond Beach, and Carkeek Park along with other Metro staff.

Costs. For Alternative C, the estimated capital cost for construction of new treatment facilities, collection systems, combined sewer overflow controls, effluent disposal site, sludge handling and disposal facilities (excluding Renton) would be $250,800,000 (1976 dollars) as summarized in Table 3-13 (Metropolitan Engineers, 1977). This is 0.26 percent of the $95,902 billion estimated by the EPA for implementation of PL 92-500 throughout the country (EPA, 1976). The operation and maintenance costs (excluding Renton) would be $8,350,000 per year, as shown in Table 3-13 (Metropolitan Engineers, 1977).

The estimated average monthly user charge per equivalent connection for the next 20 years would be $7.05 per month if all future facilities to 2005 are grant eligible, as shown in Table 3-14. User charges would be $8.15 per month if future capacity beyond 1985 is not grant eligible, and would be $13.70 per month if no future facilities are grant eligible. Since Alternative C does not comply with the secondary treatment requirement of PL 92-500, which is a condition for grant funding, it appears that the probable user charge would be $13.70 per month, an amount $5.30 greater than the average charge for Alternative B of $8.40. Impact of cost would be adverse, moderate, long-term, irreversible, and probable (depending on funding eligibility assumptions).

Since the requirements of PL 92-500 for secondary treatment would not be met, a substantial legal fine may be levied, as indicated in the section on legal and institutional impacts.

Any change in neighborhood property values as a result of the location of interceptor, holding tank or regulator construction sites in the proposed area would exist only for the duration of construction, probably about six months. There is insufficient evidence to suggest what these changes might be.

Social, recreational and cultural. Alternative C would not fulfill a goal of complying with secondary treatment as expressed by 54 to 64 percent of citizens surveyed (HRPI, 1976). This is considered adverse, major, long-term reversible and probable.

CSO control at Lake Washington swimming beaches and Ship Canal boating regions could make these areas more pleasant for recreation. This is considered favorable, minor, long-term, irreversible and probable.

Impacts on the parks or recreational areas near West Point, Carkeek Park and Alki (until abandoned) would remain at existing levels, as described in the site-specific EIS volumes.

Recreational opportunities in the West Seattle area could be increased if the Alki treatment plant buildings are demolished on abandonment of the facility in 1995 and the area landscaped. These measures are optional, however, and not costed into the facilities planning alternative.

Archeological and historical. Information is not available to determine if archeological sites are present in areas affected by construction of interceptors, holding tanks, or pump stations. The Diagonal Avenue site is across the Duwamish River from a recently discovered, archeologically significant region. Before construction occurs at Diagonal Avenue, this site should be investigated.

Acknowledged historical sites are listed in Appendix F. Available maps are not accurate enough to determine the exact location of these sites. It should be determined whether the Belvoir and Naval Reserve holding tanks conflict with historical sites in those areas, and whether the North interceptor parallel conflicts with Hiram Chittenden Locks.

Health and safety. Shellfishing areas along saltwater beaches near wastewater treatment plants could be benefited by improved water quality from enhanced primary treatment and improved disinfection practices. Combined sewer overflow reductions off Alki Beach and an improved outfall there (1983-1995) may improve local areas where shellfish and algae are harvested for consumption. However, since the cause(s) of present contamination leading to coliform levels exceeding commercial shellfishing levels has not been determined, the future impacts cannot be projected with certainty. Another contributing factor under Alternative C is that primary treatment would continue except in summer; therefore, it is conceivable that bacterial levels could at times continue to exceed commercial shellfishing standards.

At Lake Washington beaches, virtual elimination of combined sewer overflows would remove a source of bacterial contamination and increase the likelihood that body-contact recreation (swimming) standards would be achieved.

A highly unlikely safety hazard is accidental leakage of chemicals when they are in transport, or handled on site. Although nearly every U.S. water and wastewater treatment facility uses chemicals, there have been very few chemical-related accidents.

The health and safety problems related to sludge transport and disposal would be as probable as for any other trucks in transit.

Construction hazards would include local increases in air pollution, creation of an attractive hazard for neighborhood children, possible increased risk of automobile accidents due to street blockages and traffic congestion, and safety risks to workmen.

Aesthetics and nuisance. Aesthetic and nuisance factors from wastewater treatment plants would continue at existing levels. Unless controlled by a new Metro program (under consideration), odor would continue to be a problem at Alki until its abandonment in 1995. For more details, the reader is referred to Chapter II (existing conditions) and the site-specific EIS series.

Construction of the interceptors and regulator stations would cause an adverse, minor, short-term, reversible, and probable impact, especially at the Montlake regulator station, where construction would occur along a major bridge across the Ship Canal.

Community character and appearance could be temporarily affected by various construction activities, including construction traffic through the neighborhood and equipment stored on-site, contruction noise, and vibration. Erosion of excavated material could result in muddy runoff in the surrounding downhill streets.

Odor would probably not be a problem in cooler months in construction of holding tanks and regulators. Some odor problems could occur if sewer lines were opened in warm summer months, periods of low flow and concentrated sewage. Where CSO's are controlled, long-term odor reduction would occur.

There would be some aesthetic impacts from construction equipment, the possible removal of vegetation and the generally disrupted appearance of the site. The degree of aesthetic and nuisance impacts is determined by the extent to which the surrounding community views those impacts as adverse. In some cases, these have been seen as substantial (Metro, Montlake Regulator Station Draft EA Technical Appendix October 1975. Final EA March 1976).

Neighborhoods affected by the construction of Metro combined sewer overflow control facilities would be West Seattle, Rainier Beach and Sayres Park areas on Lake Washington, the Belvoir district near the University, and Magnolia. Since the interceptors, holding tanks and regulator stations would be installed underground, there would be no impact on community aesthetics once construction is completed.

Commercial enterprise. One of the important primary impacts of Alternative C concerns commercial fisheries. Improvements in the water quality and biologic conditions resulting from CSO control to freshwater spawning areas and some migration routes would benefit presently affected fisheries. Such improvements are significant because of the economic importance of the fisheries presently concerned with product quality due to water pollution limitations.

Secondary Impacts

The secondary impacts of Alternative C would be caused by the expansion of Renton, population growth, and leachate from sludge disposal. Impacts on water quality, biology, energy and natural resources, and the human environment are described below. The direct impacts on water quality from population growth and its effect on wastewater treatment plant flows have been described under primary impacts.

Water Quality

Duwamish estuary. Under Alternative C, the Renton plant would be expanded significantly. Average daily flows of 99 mgd would equal 70 percent of Duwamish summer low flows. The resulting flow augmentation could help alleviate temperature problems which develop in summer, but probably will not improve oxygen levels due to the residual BOD. The addition of nitrification and filtration following secondary treatment should remove most ammonia and solids prior to discharge. Therefore, the toxicity associated with ammonia plus metals (and perhaps other toxicants) associated with solids should be reduced relative to Alternative B. Since nitrification would convert ammonia to nitrates, these nutrients would be readily available in the Duwamish. Although improved relative to Alternative B, the overall adverse impact of the Renton expansion is expected to be significant, because of the large size of the discharge relative to the Duwamish flow, and extensive, becuase the discharge could affect Elliott Bay as well as the Duwamish. Effects would be long-term and reversible.

Groundwater. By 2005, there would be an unsewered population of 24,000 in the Metro area, which could presumably use septic tanks. Because the unsewered population would be small (as in Alternative B) and groundwater use is limited, any impacts would be minor.

Leachate runoff at the Cedar Hills sanitary landfill would not be a problem. The soil is quite impervious, limiting groundwater flows to about a foot a year. The leachate waters at Cedar Hills will be collected in a system of pipes which is now under construction. Runoff streams from the sludge basins visibly have good quality.

Surface waters. Increasing urbanization around freshwaters (such as Lake Sammamish) could adversely affect water quality from increased amounts of urban runoff.

Biology

The Renton facility expansion to 99 mgd average would affect Duwamish biology since the effluent would comprise about 70 percent of the river's summer flow.

Phytoplankton communities would change, due to the increased freshwater flows, as would zooplankton. The estuarine waters would also carry an increased summer silt load due to extra flow, reducing transmittance of light. This could have a decreasing effect on phytoplankton bloom levels. Zooplankton, which are suspension feeders, ingest not only phytoplankton but other particulates of various sizes. If the latter are from contaminated sediments and are resuspended by increased flows, the contaminants may enter the generalized food chain which includes zooplankton, small fish, and larger fish. In addition, contaminants in sediments could also be taken in directly by worms and other deposit feeders which are, in turn, consumed by fishes, birds and other vertebrates.

The Renton effluent would stress all of these organisms, due to its DO of about 2 mg/l. The increase freshwater flow would also change the salinity distribution, such that summer blooms may consist of freshwater rather than marine phytoplankton. The additional flow would also mean better flushing of the estuary. Nitrogen inputs would be in the form of nitrates, which are not oxygen demanding as is ammonia, but which could contribute to algal productivity extremes in the estuary.

Energy and Natural Resources

Energy. For Alternative C, a net of 64 million equivalent kwh/year of energy would be consumed in 2005 at Renton. Included in this would be 51 million kwh/year of electrical energy purchased, 1 million kwh/year required to produce the chemicals consumed. A net of 5 equivalent kwh/year would be produced by the process of anaerobic digestion, although only about half of this would probably be used. The impact of the energy consumption would be adverse, moderate in magnitude, long-term, irreversible and definite.

Chemicals. Chlorine, lime, and polymer would be used at annual rates of 1160, 9080 and 1315 tons, respectively, at Renton. The supplies of chlorine and polymer are reliable; lime is in moderate supply. The impact of chemical usage would be adverse, moderate, long-term, irreversible, and definite.

Human Environment

Land use, population and employment. The major CSO reduction alternative would probably result in a slight facilitation of regional growth over the long-term due to the improvement of preservation of freshwater quality. It is concluded that such protection of water quality will contribute to the continuation of the region's current national image as a desirable place to live due to the generally high quality of the natural environment. While the specific cause-effect relationships which contribute to such impacts are difficult if not impossible to quantify, it is reasonable to expect that nationally more economic growth will tend to occur in the regions of higher environmental quality. If regions, such as Puget Sound, which presently have a relatively high environmental quality, maintain or improve these conditions, it is logical to expect that the encouragement to economic development will be greater than if they are allowed to deteriorate. This impact can be either beneficial or adverse depending on the characteristics of the development which occurs and the values of the people affected.

Operation and management employment at Renton, a secondary impacted facility would include 76 people, as well as other Metro related staff. Construction would involve approximately 350 employees for 5 years.

Costs. If Alternative C is implemented, capital costs for construction at Renton would be $195,200,000 (1976 dollars) as indicated in Table 3-13. Renton operation and maintenance would cost an estimated $5,950,000 per year. The effect of this on user charge is noted in the primary impact section, since user charges are determined on a Metro-wide basis.

Impact of cost would be adverse, moderate, long-term, irreversible and definite.

Social, recreational and cultural. The secondary beneficial impact on boating in Lake Washington and the Ship Canal is considered to be minor and of a limited extent but long-term and important. The impacts would result from improved wet weather management. Swimming would be significantly benefited by Alternative C due to the improvement in Lake Washington resulting from better combined sewer overflow control.

Commercial enterprise. The expansion of the Renton sewage treatment plant under this alternative is expected to have an adverse, long-term, and reversible impact on commercial fisheries in the Duwamish due to the reductions in water quality discussed previously.

Mitigation Measures

Several mitigation measures are suggested to aid in the reduction of adverse impacts resulting from the implementation of this alternative.

An improved chlorine feed system can be designed to prevent chlorine levels in the Alki, Carkeek Park, and Richmond Beach sewage treatment plants' effluent water from exceeding dangerous levels. This could be achieved by matching chlorine levels to effluent discharge, and/or installing a chlorine contact tank, which would maximize the effectiveness of chlorination treatment. Currently chlorine is injected into the effluent flow at a constant rate, manually adjusted on a daily basis. Hourly variations in flow cause a fluctuating chlorine residual. Control of chlorine residuals at West Point could be achieved by installing a chlorine contact tank.

Pretreatment of industrial wastes could be provided before sewage enters the West Point plant. If current practices continue, influent flows at this facility would occasionally contain slugs of cadmium, mercury, and arsenic.

Socioeconomic studies should be conducted in the Duwamish area to determine what the people in this community think of Diagonal Way or other sites. To date only preliminary information has been collected. Meetings with the Duwamish community are being arranged.

Under this alternative, a mitigation measure for controlling solid and metal loads in effluent water would be to use the enhanced primary treatment of alum or other chemicals year round.

Visual nuisance of the wastewater treatment facilities can be mitigated by (1) designing new facilities and additions to existing facilities using natural geographical conditions (e.g., bluffs) and (2) landscaping the facilities.

Odor of the wastewater treatment facilities can be mitigated, in part, by not allowing the system to become anaerobic. Under anaerobic conditions, noxious gases such as methane and sulfur dioxide are emitted. Other odor control measures are being evaluated by Metro.

The energy impact can be in part defrayed by using more of the methane gas which is produced by anaerobic digestion. Nearly half of this methane gas is flared off under current practices. However, studies on the cost-effectiveness of storing and/or transporting excess methane should be conducted before a recommendation is made.

Unavoidable Adverse Impacts

Under Alternative C (Major CSO Control), the following adverse impacts would be unavoidable

- Construction
- Sludge trucking
- Primary and enhanced primary effluent - effect on water
- Land use changes
- Aesthetic nuisance of plant location
- Noncompliance with PL 92-500
- Operation and maintenance (O & M) and capital costs
- Energy expenditures.

For greater detail on unavoidable adverse impacts, the reader is referred to the preceding analysis of impacts.

ALTERNATIVE D
PARTIAL COMBINED SEWER OVERFLOW CONTROL

The description of Alternative D and its projected impacts to the year 2005 are presented in this section.

Description

Alternative D addresses the local problem of combined sewer overflows by providing partial CSO control. Those areas most sensitive to overflow impacts, namely Lake Washington and Lake Union, would receive substantial CSO reduction (83 and 61 percent, respectively) compared to Alternative B. However, the overall CSO control in the study area would be only 16 percent by volume of flow relative to Alternative B. Puget Sound treatment plants would provide enhanced primary treatment in this alternative.

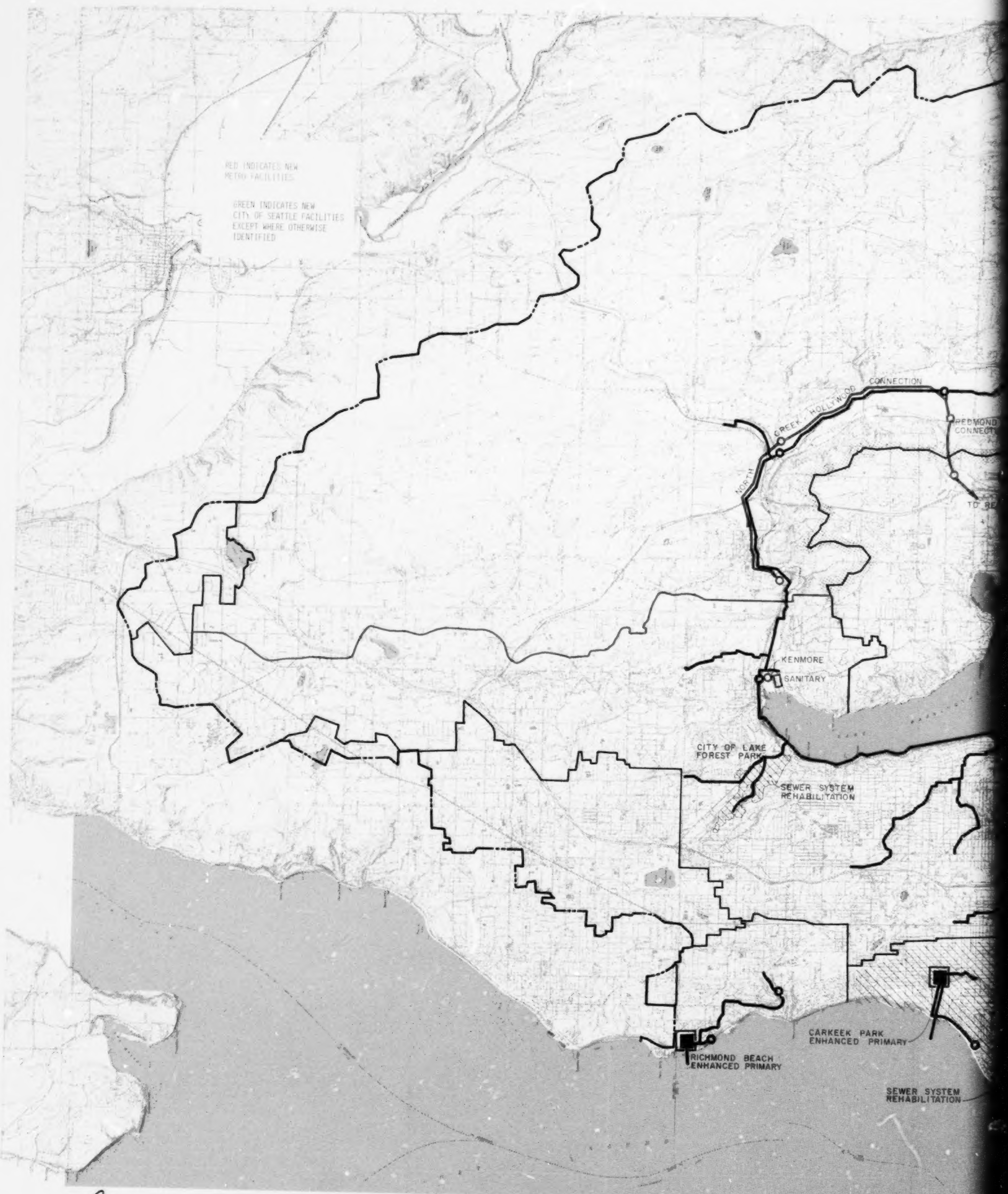
The major wastewater facilities proposed for Alternative D are illustrated in Figure 3-12. Major features of the alternatives are summarized in Table 3-22, including treatment plants, effluent discharges and combined sewer overflows, and major new transfer facilities. The construction schedule and costs for proposed facilities are shown in Table 3-23.

The alternative is further described below in terms of service area, treatment plants (location, treatment process, effluent disposal site), combined sewer overflow control, sludge management. The indirect impacts of the facilities proposed under this alternative on the Renton plant are also described.

Service Area

The service area of Alternative D would be as shown in Figure 3-1. The Richmond Beach, Carkeek Park and Alki service areas would remain the same as in existing conditions. Some reductions of the West Point service area would result by transferring flows from part of the North Lake Washington and all of the North Lake Sammamish sewerage service subareas to Renton.

The new transfer interceptors that would be needed to facilitate the service area modifications would be the Redmond connections (two stages completed in 1983 and 1995),


RED INDICATES NEW METRO FACILITIES
GREEN INDICATES NEW CITY OF SEATTLE FACILITIES EXCEPT WHERE OTHERWISE IDENTIFIED
NORTH CREEK - HOLLYWOOD CONNECTION
REDMOND CONNECT
TO RE
KENMORE SANITARY
CITY OF LAKE FOREST PARK
SEWER SYSTEM REHABILITATION
RICHMOND BEACH ENHANCED PRIMARY
CARKEEK PARK ENHANCED PRIMARY
SEWER SYSTEM REHABILITATION

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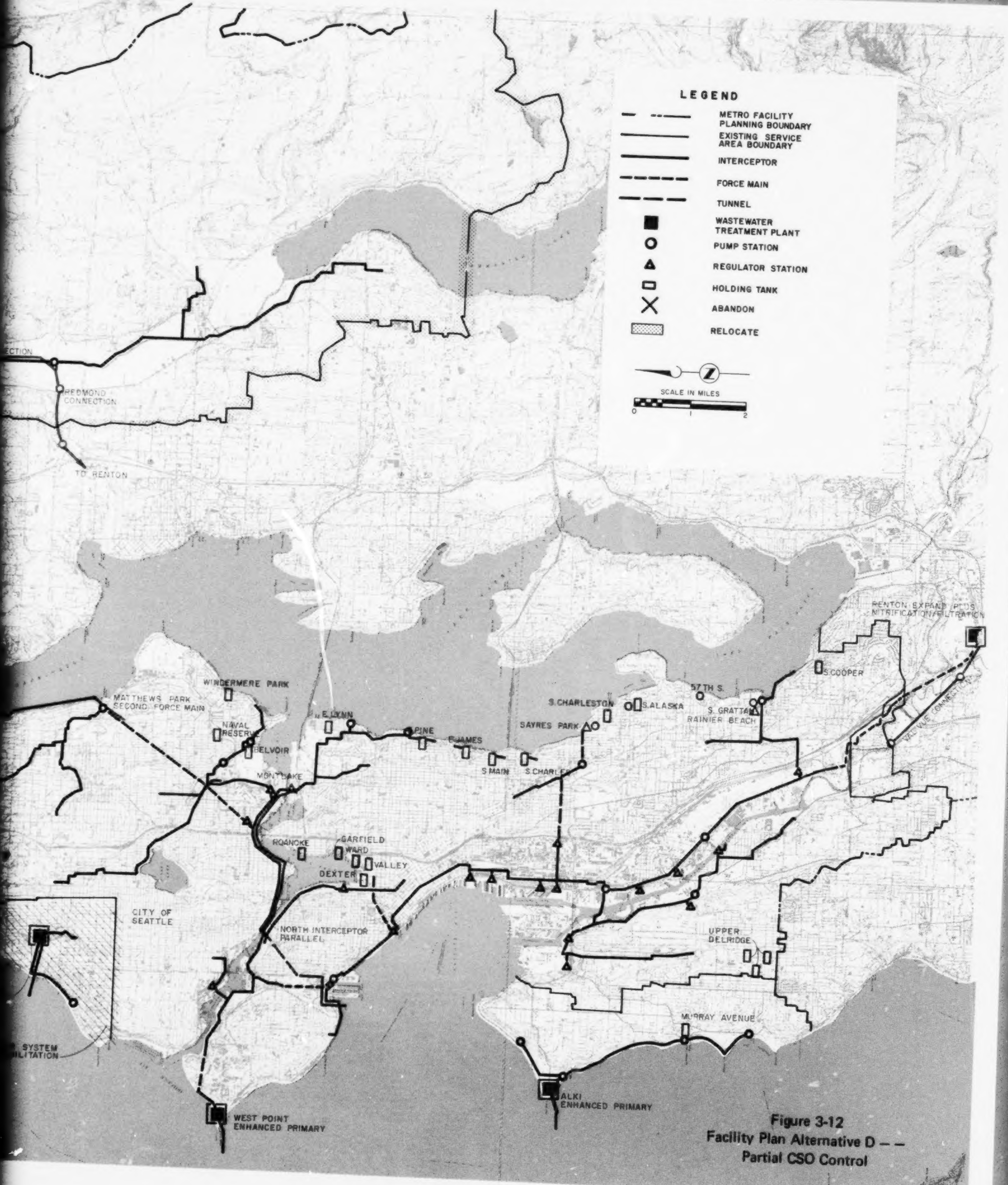

LEGEND
METRO FACILITY PLANNING BOUNDARY
EXISTING SERVICE AREA BOUNDARY
INTERCEPTOR
FORCE MAIN
TUNNEL
WASTEWATER TREATMENT PLANT
PUMP STATION
REGULATOR STATION
HOLDING TANK
ABANDON
RELOCATE
SCALE IN MILES
0
1
2
ECTION
REDMOND CONNECTION
TO RENTON
RENTON EXPAND PLUS NITRIFICATION/FILTRATION
S.COOPER
57 TH S.
S.CHARLESTON
S.ALASKA
S. GRATTAN
RAINIER BEACH
SAYRES PARK
WINDERMERE PARK
MATTHEWS PARK SECOND FORCE MAIN
NAVAL RESERV
BELVOIR
E.LYNN
PINE
E.JAMES
S.MAIN
S.CHARLES
MONTLAKE
ROANOKE
GARFIELD
WARD
VALLEY
DEXTER
CITY OF SEATTLE
NORTH INTERCEPTOR PARALLEL
UPPER DELRIDGE
MURRAY AVENUE
BELLEVUE CONNECTION
SYSTEM
ILITATION
WEST POINT ENHANCED PRIMARY
ALKI ENHANCED PRIMARY

Figure 3-12
Facility Plan Alternative D — —
Partial CSO Control

B

TABLE 3-22

ALTERNATIVE D- PARTIAL COMBINED SEWER OVERFLOW REDUCTION SUMMARY

TREATMENT PLANTS

	WEST POINT	ALKI	CARKEEK PARK	RICHMOND BEACH	RENTON*
Process	Enhanced Primary	Enhanced Primary	Enhanced Primary	Enhanced Primary	Secondary + Nitrification and Filtration
Improvement Completed	1985	1985	1985	1981	1995
Flow (mgd) 2005 (unless phased)	129/350	10/30	3.5/20	2.5/9	99/259
Disposal	Puget Sound	Puget Sound Outfall Extended	Puget Sound	Puget Sound	Duwamish

COMBINED SEWER OVERFLOW (2005)

	FLOW (Million Gallons/Yr)	SOLIDS (Tons/Yr)	BOD (Tons/Yr)
Lake Washington	3.76	3.41	0.94
Lake Sammamish	0	0	0
Portage Bay/Montlake Cut	147	133	36.5
Lake Union	22	20.1	5.52
Ship Canal/Salmon Bay	128	116	31.8
Elliott Bay	433	392	108
Alki Beach	4.47	4.06	1.11
Duwamish/Green River	251	227	62
TOTAL	989.4	895.6	245.9

TREATMENT PLANT DISCHARGE

	FLOW (Million Gallons/Yr)	SOLIDS (Tons/Yr)	BOD (Tons/Yr)
West Point	54,000	10,500	14,200
Alki Beach	3,650	710	964
Carkeek Park	1,530	297	404
Richmond Beach	912	177	241
Renton	36,050	753	1,508
TOTAL	96,142	12,437	17,417

MAJOR NEW TRANSFER FACILITIES

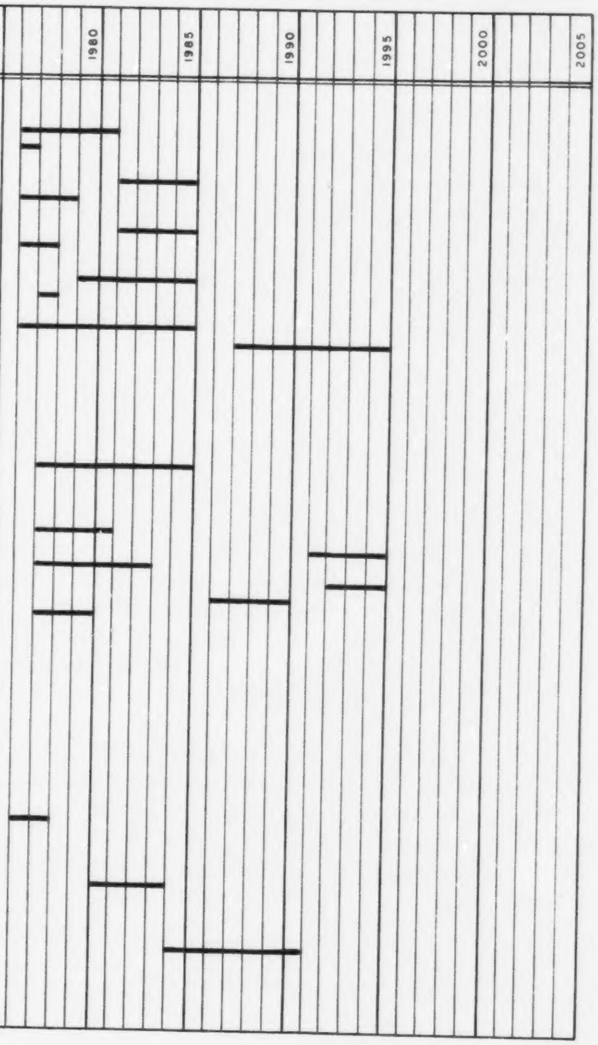
Location	Year Completed
Redmond Connection - Stage I	1983
Redmond Connection - Stage II	1995
North Creek - Hollywood Connection	1990
Val Vue Connection (to Renton)	1980

*Not included in proposed facilities plan for Puget Sound plants

Table 3-23

Alternative D -- Project Costs and Construction Staging

Facility Component	Project Cost $ Million ENR-CI - 2600
Treatment Plants	
Richmond Beach Upgrade to Enhanced Primary Treatment	1.1
Carkeek Park - Interim Improvements	0.1
Carkeek Park - Upgrade to Enhanced Primary Treatment	1.5
West Point - Interim Improvements	4.8
West Point - Upgrade to Enhanced Primary Treatment	13.2
Alki - Interim Improvements	0.3
Alki - Upgrade to Enhanced Primary Treatment	14.7
*Renton - Interim Improvements	0.4
*Renton - Enlargement II and Upgrading (Nitrification, Filtration, Sludge)	79.5
*Renton - Enlargement III	57.0
Subtotal - Treatment Plants (Including Outfalls)	172.6
Collection System	
Rehabilitation of Existing Collection System	15.6
*Increased Transfer Capacity Within West Point Existing Sewered Areas	
Kenmore P.S. (Permanent)	2.8
Holding Tank - Kenmore P.S.	5.1
Redmond Connection - Stage 1	17.0
Redmond Connection - Stage 2	3.0
North Creek - Hollywood Connection	8.0
Val Vue Connection (to Renton)	7.8
Increased Transfer Capacity and Rehabilitation within Renton Existing Sewered Areas	27.3
Subtotal - Collection System	86.6
Combined Sewer Overflow Control	
Montlake Regulator Station	0.8
Lake Washington CSO Holding - Rainier Beach and Sayres Park Regulator Stations and a Holding Tank at Belvoir Pump Station; 1/yr level	6.7
Lake Washington Holding + Transport North Int. Parallel Line, Dexter Holding Tank, HT at Murray P.S. 10/yr level	34.7
Subtotal - Hold and Transport CSO	42.2
Total Capital Cost	301.4



*Note: Renton facilities are not part of the proposed facilities plan.

the North Creek-Hollywood connection (1990) and Val Vue connection to Renton (1980).

Construction schedule for these collection system modifications would be as in Table 3-23.

Treatment Plants

The wastewater treatment facilities under Alternative D would be as shown in Table 3-22. The four Puget Sound plants would be upgraded to enhanced primary to provide treatment during the remainder of the planning period (2005). The chemical addition for enhanced primary treatment would only be applied during the summer months; during the remainder of the year the four plants would operate with primary treatment.

The enhanced primary or primary effluent would be discharged to Puget Sound through the existing plant outfalls at West Point, Carkeek Park and Richmond Beach. The Alki outfall would be extended and improved.

The Alki, Carkeek Park and Richmond Beach plant capacities would remain as in Alternative B since no changes would be made to the service areas. The West Point average flow would be reduced to 129 mgd due to reductions in the service area and transfer of some flow to Renton. However, no change in the existing plant size would result.

All plants would fit on the existing plant property and would involve only minor additions for chemical storage and application. Plant layouts would be as in Alternative C (except the Alki abandonment phase), shown in Figure 3-11. Improvements would be complete by 1981 at Richmond Beach and by 1985 at West Point, Alki and Carkeek Park.

Combined Sewer Overflow

In Alternative D, combined sewer overflow controls would result in substantial flow reductions to Lake Washington (83 percent), Lake Union (61 percent), and the Ship Canal (50 percent), relative to Alternative B. By providing both Metro and City holding and transport facilities, shown in Figure 3-12, overflows to Lake Washington would be controlled to one event per year, and in Lake Union and along the West Seattle shoreline to ten events per year. Little control of other overflows beyond the existing CATAD (Computer Augmented Treatment and Disposal) system, is provided in this alternative.

In controlling CSO's to freshwaters, this alternative would transfer some flows to saltwater. As a result, CSO's to Elliott Bay would increase from 358 million gallons per year (in existing conditions or Alternative B) to 433 million gallons per year in Alternative D. To discharge these untreated storm water flows, a new 1200 foot outfall would be constructed to Elliott Bay from the Interbay area, as shown in Figure 3-12. It would discharge peak flows of 80 mgd at a 50 foot depth west of Terminal 91.

The facilities that would be constructed to achieve partial CSO control would be as in Tables 3-20 and 3-22. Figure 3-12 shows general locations at the holding tanks.

Sludge Management

The sludge management system for Alternative D would continue with West Point as a major regional sludge processing center. However, Renton sludge, presently treated at West Point, would be treated at Renton under this alternative. At the four Puget Sound plants, solids handling facilities would be expanded as required to handle the additional solids load from increasing flows and enhanced primary treatment.

Richmond Beach digested sludge would be trucked to West Point for dewatering. Dewatered sludge from Alki, Carkeek Park, West Point and Renton would be trucked to the Cedar Hills landfill and the Pack Forest site as an interim sludge disposal procedure.

Anaerobic digestion would be used for sludge treatment at West Point, Alki, Carkeek Park and Richmond Beach. The methane gas produced by the process would be used to the extent possible at each site.

Renton

Although the Renton service area and treatment plant are not included in the proposed facilities for Alternative D, the alternative would have secondary or indirect impacts on the Renton plant. Due to revisions in service areas, the Renton plant would receive some flows that would otherwise have been treated at West Point.

The Renton plant would be expanded to handle increasing flows in two stages, completed in 1985 and 1995, to an ultimate capacity of 99 mgd for average and 259 mgd for peak flow. Because the effluent would continue to be discharged to the Duwamish, it would be treated by an upgraded process beyond secondary. Nitrification (for converting organic nitrogen compounds to nitrates) and filtration (for better solids removal) would be provided.

Sludge would be processed at Renton by anaerobic digestion, dewatered there, and trucked to the Cedar Hills landfill.

Primary Impacts

The direct impacts from this alternative for the Puget Sound plants are described below in terms of effects on geology, soils and topography; air quality and odors; water quality; biology; energy and natural resources and the human environment. Indirect impacts from this alternative and the effects of Renton discharge are summarized under a later section on secondary impacts.

Geology, Soils and Topography

Construction impacts on land resources at treatment plant sites are discussed in the accompanying site documents (Volume II of the EIS).

Earthquake damage risk would continue at existing sites and be correlated with physical factors at new sites as expressed in Chapter II. Holding tanks constructed in lowland areas, for which exact sites are undetermined, have potentially high earthquake damage risk and would need to be constructed with that consideration. These tanks may also permanently affect wetland and shoreline areas and shore protection structures. Since Alternative D includes fewer holding tanks than Alternative C, impacts associated with tanks would be less than for Alternative C.

Impacts would continue at existing sludge disposal sites. As in Alternative C, the additional sludge from enhanced primary treatment and larger flows would not affect the expected 30 year life of the Cedar Hills landfill site. Impacts would be monitored there and at Pack Forest.

Construction waste disposal may cause minor, limited, but long-term effects on the site chosen. The impact is set by judgment as no sites have been identified and the magnitude of the impact is a function of site.

The seven proposed collection system projects to hold and transport CSO's under Alternative D, listed in Table 3-20 and approximately mapped in Figure 3-12, could have local impacts. Since holding tanks, regulator stations, and interceptor sewer would be placed underground, excavation would disrupt soil profiles, temporarily accelerate erosion and deposition, and could cause problems at excavation waste disposal sites. The new facilities would be subject to the usual minor risk of earthquake damage. More specific impacts cannot be projected because information on sites is not available. Construction at the North parallel interceptor, installed along the north shore of Lake Union and across the Ship Canal 3 miles east of Shilshole Bay, would disturb bottom sediments over a limited area and for a short time (six months). These impacts on soil and sediments would be reversible.

Irreversible impacts would result from the construction of a tunnel more than a mile long and 7 feet in diameter under the northwest portion of Queen Anne Hill from the Ship Canal to the Interbay station. Disposal of almost 9,400 cubic yards of excavated material could have serious adverse effects on the disposal sites chosen.

Air Quality and Odors

Trucking sludge from Richmond Beach to West Point and from West Point, Carkeek Park, Alki and Renton to the Cedar Hills landfill would emit approximately 435 grams of hydrocarbons, 2710 grams of carbon monoxide, and 1975 grams of nitrogen oxides per day. Treatment plant personnel traffic would emit approximately 4205 grams of hydrocarbons, 53510 grams of carbon monoxide, and 6930 grams of nitrogen oxides per day. The combined emissions would amount to less than 0.01 percent of Seattle's total daily emissions of hydrocarbons, carbon monoxide, and nitrogen oxides. The air pollutants emitted under this alternative would have a negligible, long-term, adverse, reversible impact on the air quality of the Seattle area. Emissions would increase for sludge transport to Pack Forest, but the overall impact on air quality would be negligible.

Upgrading the Richmond Beach, Carkeek Park, Alki and West Point plants to enhanced primary treatment will not noticeably increase the potential for odor problems in these areas, as described under Alternative C. The substantial decrease of CSO's into Lake Washington and Lake Union would appreciably reduce the associated odors at overflow points. CSO's and their odors would be reduced somewhat in Portage Bay and the Ship Canal. The odor problems associated with the plants and CSO's under this alternative would have a minor, adverse, long-term, reversible impact on the area's environmental quality.

The construction of enhanced primary treatment facilities and proposed collection system improvements listed in Table 3-20 and shown in Figure 3-12 would cause temporary increases in particulates (dust) and engine emissions (exhaust fumes) over limited areas. These problems would be intensified for projects in the Interbay Valley (North interceptor parallel and outfall) where air circulation can be restricted, entrapping air pollutants. The pollution potential would be least in West Seattle where air circulation is best. Some release of odors could be expected if existing sewer lines are opened in warm summer months.

Water Quality

Provision for enhanced primary treatment at the West Point, Alki, Carkeek Park and Richmond Beach plants, with partial CSO control will have mixed impacts on water quality.

Construction of CSO holding and transport facilities (listed in Table 3-20 and shown in Figure 3-12) would result in long-term benefits but short-term adverse impacts on water quality. Erosion of excavated areas would increase runoff turbidity, probably increasing turbidity in receiving waters. This reversible effect could be less noticeable than that of a combined sewer overflow, and would be of limited extent.

Lake Washington. Alternative D would reduce the flow, solids and BOD of CSO's to Lake Washington by 83 percent relative to Alternative B. Overflows to Lake Washington would be limited to one overflow per year. Benefits to Lake Washington water quality from lower inputs of bacteria, metals, nutrients and toxicants would be approximately the same as in Alternative C. The difference under Alternative D would be from the remaining 3.76 million gallons per year of combined sewer overflows, which could produce localized water quality degradation in the immediate vicinity of overflow points following storms. Because of the small CSO volume (relative to the lake volume) and circulation patterns, CSO's would not be expected to affect areas other than shorelines. Overall, the substantial reduction in CSO's would have beneficial, limited, minor, long-term and reversible impacts.

Lake Union/Ship Canal. Under Alternative D, combined sewer overflows to Lake Union and the Ship Canal/Salmon Bay would be reduced by 61 and 50 percent, respectively, relative to Alternative B. Overflows to Lake Union would be controlled to 10 events per year. Because present water quality is subject to coliform bacteria excesses, dissolved oxygen depletion during fish migration seasons, floatables, oil and poor circulation, improvements in water quality from CSO reduction are important. However, since not all water quality conditions are believed to stem from CSO's, reducing overflows by 50 percent or more would probably not have a major effect on receiving water quality. Overall, reductions in CSO's would be beneficial, extensive (over the entire Ship Canal plus Lake Union), minor in effect, long-term, and reversible.

Excavation in the Ship Canal would disturb sediments, temporarily increasing turbidity. Metals, toxicants and possibly pathogens in the sediment could reenter the water column and become available for biologic uptake by free-swimming organisms. This adverse impact on water quality is considered to be minor and of limited extent.

Other freshwater. Alternative D would not directly affect Lake Sammamish, Green River, Cedar River, or Sammamish River.

Duwamish estuary. Since Alternative D would not control combined sewer overflows to the Duwamish, impacts would be as in Alternative B or existing conditions. Effects of CSO's would be overshadowed, except in localized areas, by the Renton treatment plant discharge.

Puget Sound. Impacts on Puget Sound from enhanced primary (during summer) and primary (during other seasons) treated effluent from the West Point, Carkeek Park and Richmond Beach plants would be as described under Alternative C. Regional impacts on water quality would be improved relative to Alternative B, but would represent essentially a nondegradation situation or continuation of existing pollutant loads to the Sound.

One difference in Alternative D relative to the other enhanced primary treatment alternative (C) would be that the

Alki treatment plant would be used throughout the study period. Flow would be equivalent to Alternative B, but pollutant loads of solids and BOD would be reduced by about 22 percent. Considering that bacteria, toxicants and other materials would also be reduced and that the outfall would be improved, a minor beneficial, long-term impact would occur. Similarly, an 18 percent reduction in combined sewer overflows at Alki Beach could benefit the water quality nearshore. However, the remaining plant discharge and CSO's could still have adverse effects on water quality near Alki Beach.

Combined sewer overflows to Elliott Bay of 433 million gallons per year would represent a 21 percent increase over Alternative B, since the CSO's formerly reaching inland waters would be transferred to saltwaters of Elliott Bay. With the new Elliott Bay outfall off Interbay (discharging up to 80 mgd peak flows), adverse impacts on water quality would be approximately the same as Alternative C, wherein 448 million gallons per year would be discharged.

Construction of the outfall to Elliott Bay disturb sediments, increasing turbidity and possibly resuspending heavy metals and toxicants for a period of about 6 months. The discharge of up to 80 mgd of untreated storm water and sewage could adversely affect nutrients and microbiological quality in nearshore and intertidal waters. The contribution of heavy metals and toxicants to sediments would also be increased. The adverse impact on Puget Sound water quality is judged to be moderate, intermittent but continuing, and, except for the accumulation of heavy metals and toxicants, reversible.

Groundwater. Since the West Point, Alki, Carkeek Park and Richmond Beach plants would discharge to Puget Sound, no direct impacts on groundwater from these plants are expected. At Cedar Hills and Pack Forest sludge disposal sites, impacts on groundwater would be monitored.

Flood hazard. Floods are not expected to cause problems at any of the treatment plants because all sites are above the 100 year flood level.

Biology

Biological effects from enhanced primary treatment and partial CSO control are described below.

Terrestrial habitats. No regional impacts are expected from treatment plant operation. The construction of the collection system projects to hold and transport CSO's are not expected to adversely affect terrestrial ecology as the facilities would be built beneath already paved or other highly disturbed areas. Noise and vibrations from construction work could frighten birds and small mammals away from construction sites in residential areas.

Shoreline habitats. Marshes and shoreline areas of Lake Washington would receive moderate long-term benefits from 83 percent CSO control relative to Alternative B and reduced inputs of toxicants, metals, oil and grease, pathogens, BOD, and solids that can accumulate in tissues or be immediately toxic. Biota in limited areas at outflow points would probably remain lower in diversity and abundance due to toxic materials already in the sediment and from occasional overflows. Some salmon spawning areas could still be occasionally stressed.

Marshes along the Ship Canal at Union Bay and Portage Bay would receive 36 to 50 percent less overflow than in Alternative B, a benefit considered to be moderate-to-minor. The magnitude of the overall influence of CSO's on ecological communities in this water are unknown. CSO control would probably be a moderate-to-minor benefit to the immediate overflow areas, assuming the data on Roanoke (Metro Staff, 1976) are typical. The remaining overflows would continue to have a negative, limited, long-term impact.

The Kellogg Island salt marsh would receive about the same overflow loading as at present. The effect of overflows on this marsh has not been examined.

The Intertidal. Intertidal organisms would be affected by increased nutrient loads, about 25 percent above existing conditions due to higher flows, but the discharge of nitrogen-containing nutrients from wastewater treatment plants would be approximately the same as under Alternative B. Therefore, the effects of nutrient loads on intertidal alge and algae grazers would be as in Alternative B. Impacts of metals, pathogens and toxicants would be approximately as in Alternative C.

At Alki, the eelgrass beds would benefit from extending the outfall and improving effluent dilution. The effect of chemical precipitation of solids would be beneficial, but minor, since solids, BOD and some toxicants would remain about at present levels while nutrients would increase. The

18 percent reduction in CSO's would have a minor positive effect in the intertidal at Alki Beach.

Puget Sound. Since total wastewater flows and pollutant loads to Puget Sound would be virtually the same as under Alternative C, impacts would be equivalent. Included would be (1) changes in the distribution of some nearshore and offshore benthic organisms, which would probably be correlated with wastewater plume positions, (2) nutrient enrichment of plankton and some attached algae, which could affect the magnitude of blooms, (3) changes in the composition, diversity, abundance and possibly tumor incidence of fish around outfalls and (4) effects of over- and under-chlorination of wastewaters.

Since Alternative D includes the Alki plant (which would be abandoned in 1995 under Alternative C), impacts of that discharge would be in addition to other effects on Puget Sound. The extended Alki outfall would place the effluent closer to mid-channel where major algae blooms develop, but it is not known whether or not new effects would occur. Therefore, impacts on plankton blooms are considered adverse, negligible to moderate, minor, limited, long-term and possible.

Commercial and sport fisheries. Herring fisheries at West Seattle would be slightly benefited by the 18% decrease in CSO's to the eelgrass bed areas due to the reduction in metals, toxicants, oil, and grease. The salmon and trout runs up the Duwamish through Elliott Bay, however, would continue to be potentially threatened by overflows containing BOD, solids, metals, and toxicants. CSO's to the Ship Canal through Lake Washington fish run would decrease, with some moderate benefit to these fish populations. Sport shellfish would probably continue to be a potential health risk as fecal coliforms in the waters exceed state shellfish standards. Effects on juveniles of commercial species that feed in nearshore areas potentially affected by effluents would be unchanged from present, except that eelgrass beds would be less affected. The above effects are considered to be reversible, extensive on the fisheries, and of long duration.

The discharge of up to 80 mgd of untreated sewage from the North parallel interceptor through a new outfall into Elliott Bay at a depth of 50 feet could adversely affect algal productivity and nektonic and intertidal organisms. Because Elliott Bay is an important area for commercial shrimp and fishes, the adverse, long-term impact of the outfall could be moderate to major, and, except for the accumulation of toxicants, reversible.

The Duwamish estuary. Impacts of combined sewer overflows would be as described under Alternative B, but would be overshadowed by Renton discharge except at localized points. In terms of flow, suspended solids and BOD, combined sewer overflows would contribute 0.7, 30, and 4 percent, respectively, of the Renton flow in 2005.

Freshwater environments. The effects of Alternative D on freshwaters due to reduced CSO's to certain waters, such as Lake Washington and Lake Union are discussed below.

1. Lake Washington. Since CSO pollutant loads would be reduced substantially (83 percent relative to Alternative B) benefits to the sensitive, productive nearshore areas would be major, limited to the western shore, and long-term. Offshore areas would be affected less, but the overall nutrient load and BOD to the lake would also be reduced.

Salmon spawning areas would be far less threatened by siltation and exposure to toxic elements.

2. Lake Union/Ship Canal. CSO reductions of 50 to 61 percent (relative to Alternative B) would constitute a moderate improvement, but these waters would still receive approximately 150 million gallons of sewer overflows annually. The magnitude and extent of the effect on biota is unknown, but it is possible that CSO's have been cumulatively causing stresses to migrating salmon and trout. Effects at the one overflow sampled indicated clearly severe if limited negative effects on biota - no life was found at the overflow point or near the plume.

Sewer overflows may, however, be significant contributors of nutrients (nitrates and phosphates) aggravating the overenrichment of Lake Union (Metropolitan Engineers, 1976). The benefit of CSO reduction to the Ship Canal and to Lake Union is judged to be moderate but long-term.

Construction of the North parallel interceptor across the Ship Canal, a critical waterway for migrating salmon and trout of the Lake Washington drainage, would last approximately six months. Fish susceptibility to natural mortality and predation would increase for the period of construction due to disruption of the canal bottom, implacement of physical obstacles, increases in turbidity, and possible resuspension of toxic substances in the sediment. The effect is believed to be cnsiderable, although limited in extent and of short duration.

Operation of the North parallel interceptor, however, would remove CSO's from the Ship Canal and the western shore of Lake Washington, thereby reducing the water quality-induced stress on migrating and spawning salmonids in the long term.

Other waters. No impacts are expected on the biota of the Sammamish River, Cedar River, Green River or other waters of the study area.

Rare and endangered species. No impacts are anticipated under Alternative D for listed species as none are recorded from the study area. Critical habitats such as salmon spawning, rearing and migration areas, and waterfowl areas have been discussed previously.

Energy and Natural Resources

Energy and chemical consumption are summarized in Table 3-24.

Energy. For Alternative D, a net of 34 million equivalent kwh/year of energy would be consumed in 2005 by the primarily impacted plants (all but Renton). Included in this would be 28 million kwh/year of electrical energy purchased. This is equivalent to the amount of electrical energy 1400 households would consume per year, and constitutes approximately 0.14 percent of the projected electrical energy consumption of Seattle in 2005 (Appendix E).

Table 3-24 shows the breakdown of total energy consumptions on a plant-by-plant basis. The greatest energy consumed is in the form of electricity. Chemicals account for about 10-30 percent of energy consumption and sludge trucking for 5-30 percent. In the anaerobic digestion of sludge, there is a net production of energy because of methane formation. It can be expected that about half of the methane will be flared off; half would be used at the plant. The impact of the energy consumption would be adverse, moderate in magnitude, long-term, irreversible and definite.

Annual chemical consumption for enhanced primary treatment would be a total of 5410 tons lime, 535 tons ferric

TABLE 3-24

ENERGY AND CHEMICAL CONSUMPTION FOR ALTERNATIVE D

	PLANT				
	Richmond Beach	Carkeek Park	West Point	Alki	Total
ENERGY CONSUMPTION:					
Onsite Energy					
Purchased electricity (kwh x 10^6/yr)	0.66	1.05	23.79	2.47	27.97
Produced by digestion (kwh x 10^6/yr)	0.36	0.62	15.35	1.13	17.46
Consumed by digestion (kwh x 10^6/yr)	0.14	0.25	6.14	0.45	6.98
Offsite Energy					
Chemicals (kwh x 10^6/yr)	0.16	0.33	14.08	0.77	15.34
Sludge Trucking (kwh x 10^6/yr)	0.12	0.03	1.13	0.04	1.32
TOTAL	0.72	1.04	29.79	2.60	34.15
CHEMICAL CONSUMPTION					
Cl_2	35	60	1985	145	2225
CaO	40	70	5135	165	5410
$FeCl_3$	-	-	535	-	535
Alum	135	240	6545	540	7460
Polymer	0.6	5.2	35	10	50.2

chloride, and 7460 tons alum. Disinfection with chlorine would require 2225 tons per year, and sludge thickening or solids removal would require 50.8 tons/year of polymer. A plant-by-plant breakdown of chemical consumption would be as shown in Table 3-24. The supply of chlorine, alum, and polymer are highly reliable. Lime and ferric chloride are in moderate supply.

The impact of chemical usage would be adverse, minor, long-term, irreversible, and definite.

Human Environment

Alternative D would cause a 16 percent decrease in combined sewer overflows, partially enhancing the quality, healthfulness, and overall aesthetics of the Metro area waterways. However, this alternative does not comply with PL 92-500.

Land use. Land would have to be made accessible for interceptors and connections for North Creek-Hollywood, Redmond, and Val Vue; CSO holding tanks at Belvoir, Dexter, Murray, Kenmore, and other sites, and regulator stations at Montlake, Rainier Beach, Sayres Park, and North interceptor. Any of these developments which occur within 200 feet of shoreline would require a permit from the Shorelines Management Master Program of Seattle. These would include the North Creek-Hollywood Connection, the North interceptor parallel, the Montlake regulator, and may include some of the holding tanks. The interceptors and regulators would be underground, and therefore would have no impact on land use after construction. This alternative maintains land use at the Alki, West Point, Carkeek Park, and Richmond Beach plants.

Legal and institutional. Alternative D does not comply with PL 92-500 nor the Washington NPDES Regulations which require secondary treatment. A fine as high as $10,000 per day could be levied against Metro for noncompliance if this alternative were implemented. The details of this are explained in Chapter II. This impact would be adverse, major, long-term, and probable.

The Shorelines Management regulations would be applicable. Washington public health regulations for coliform standards would probably not be exceeded at Lake Washington public beaches. Probably no U.S. Army Corp of Engineers permits would be required.

Agency goals. Alternative D was originally established to address Metro's best practicable treatment (BPT) goal of identifying and solving water quality problems in the Metro service area. In relation to Alternative B, Alternative D reduces but does not eliminate combined sewer overflows to Lake Washington, Portage Bay/Montlake Cut, Lake Union, Ship Canal/Salmon Bay and Alki Beach, but increases CSO's to Elliott Bay. For impacts on water quality, see the discussion in that section.

However, it is speculative whether this alternative fulfills the objectives of Goals for Seattle, which states, "the city should undertake efforts to meet Federal Water Pollution Control Act requirements by 1984." This alternative does not alleviate the frequent odor problem at Alki, which (in addition to affecting the Alki residents directly) conflicts with the PSCOG goal of "maintaining the natural beauty and liveability of the region."

Employment. There would be approximately 200 employees for five years required for the construction involved in Alternative D. Operation and management employment would require a total of 76 employees at West Point, Alki, Richmond Beach and Carkeek Park along with other Metro staff.

Costs. For Alternative D, the estimated capital cost for constructing new treatment facilities, collection systems, combined sewer overflow controls, effluent disposal sites, sludge handling and disposal facilities (excluding Renton) would be $106,800,000 (1976 dollars) as summarized in Table 3-13 (Metropolitan Engineers, 1977). This is 0.11 percent of the $95,902 billion estimated by the EPA to be required for implementation of PL 92-500 throughout the country (EPA, 1976). The operation and maintenance costs (excluding Renton) would be $6,350,000 per year, as shown in Table 3-13 (Metropolitan Engineers, 1977).

The estimated average monthly user charge per equivalent connection for the next 20 years would be $6.40 per month if all future facilities to 2005 are grant eligible, as shown in Table 3-14. User charges would be $7.65 per month if future capacity beyond 1985 is not grant eligible and would be $11.10 per month if no future facilities are grant eligible. Since Alternative D does not comply with the secondary treatment requirement of PL 92-500, which is a condition for grant funding, it appears that the probable user charge would be $11.10 per month, an amount $2.70 greater than the average expected charge for Alternative B of $8.40.

Impact of cost would be adverse, moderate, long-term, irreversible, and definite.

If the requirements of PL 92-500 for secondary treatment not complied with, additional costs could result from a substantial legal fine which may be levied, as indicated in the section on legal and institutional impacts.

Social, recreational and cultural. Alternative D would not fulfill a goal of 54 to 64 percent of people surveyed (HRPI, 1976) that expressed a preference for secondary treatment.

CSO control at Lake Washington beaches and Ship Canal boating regions could make these areas more pleasant for recreation. This is considered favorable, minor, long-term, reversible, and probable.

Impacts on the parks or recreational facilities near the West Point, Alki and Carkeek Park plants would continue as under present conditions. For more detail, the site-specific EIS documents should be consulted.

Archeological and historical. Information is not available to determine if archeological sites are present in areas affected by construction of interceptors, holding tanks or pump stations.

Acknowledged historical sites are shown in Appendix F, but available maps are not accurate enough to determine the exact location of these sites. It should be determined whether the Belvoir holding tanks conflict with historical sites in this area, and whether the North interceptor parallel conflicts with Hiram Chittenden Locks.

Health and safety. In Puget Sound there may be health problems related to the ingestion of shellfish in the regions adjacent to wastewater outfalls if these facilities have only enhanced primary or primary treatment of wastes or if the areas are near combined sewer overflow points. These impacts could continue under Alternative D.

Another highly unlikely safety hazard is accidental leakage of chemicals when they are in transport or handled on site. Although nearly every U.S. water and wastewater treatment facility uses chemicals, there have been very few chemical-related accidents.

The health and safety problems related to sludge transport and disposal would be as probable as for any other trucks in transit.

Construction hazards would be the same as for any other similar construction.

Aesthetics and nuisance. Since treatment plants would receive only minor modifications for enhanced primary treatment, aesthetics and nuisance factors would not change appreciably relative to present conditions. Odor could continue to be a nuisance at Alki during the duration of the study period, but Metro is currently considering odor control possibilities. Overall, impacts are considered adverse, minor, long-term, reversible and definite.

Construction of the collection system improvements designed to hold and transport CSO's could temporarily degrade community character and appearance. The noise, vibrations, storage arrangements and traffic of construction machinery could affect residents in the Kenmore, Matthews Park, Belvoir, Sayres Park, and Rainier Beach areas. Erosion of excavated material could result in muddy runoff down surrounding streets. Odor from sewers opened during construction of interceptors and holding tanks would probably not be a problem in cooler months. If sewers were opened during the summer periods of low flow and concentrated sewage, there could be some odor. The overall degree of nuisance caused by construction activities is determined by the extent to which the surrounding community objects to these impacts. In some cases, the nuisance has been strongly felt (Metro, Montlake Regulator Station Draft EA, Technical Appendix, October 1975; Final EA March 1976). Communities which would be affected are Kenmore, Matthews Park, Belvoir and Interbay. Since the interceptors, holding tanks and regulator stations would be installed underground, there would be no impact on community aesthetics once construction is completed.

Secondary Impacts

The secondary or indirect impacts of the alternative would result from expanding the Renton treatment plant and population growth. The effects of these changes on water quality, biology, energy, natural resources and the human environment are described below.

Water Quality

Secondary impacts on water quality from Renton effluent discharge to the Duwamish would be as described for Alternative C. Additional population would increase urban runoff to freshwaters, and could have a minor impact on groundwaters in unsewered areas, as described in Alternative B.

Biology

Secondary impacts from Renton treatment plant discharge on phytoplankton, zooplankton, deposit feeders, fishes and birds would be as described under Alternative C.

Energy and Natural Resources

Energy. For Alternative D, a net of 63 million equivalent kwh/year of energy would be consumed in 2005 at Renton. Included in this would be 57 million kwh/year of electrical energy purchased, 1 million kwh/year for sludge trucking, and 11 million equivalent kwh/year required to produce the chemicals consumed. A net of 5 equivalent kwh/year would be produced by the process of anaerobic digestion, although only about half of this would probably be used. The impact of the energy consumption would be adverse, moderate in magnitude, long-term, irreversible, and definite.

Chemicals. Chlorine, lime and polymer would be used at annual rates of 1160, 9080, and 1315 tons, respectively. The supplies of chlorine and polymer are reliable; lime is in moderate supply. The impact of chemical usage would be adverse, moderate, long-term, irreversible, and definite.

Human Environment

Land use, population and employment. The partial combined sewer overflow control alternative would probably result in a slight facilitation of regional growth over the long term due to the improvement or preservation of water quality in inland waters as described under Alternative C.

Operation and management employment at Renton would be 76 people as well as other Metro related staff. Construction would involve approximately 350 employees for five years.

Costs. Capital costs for construction at Renton would be $195,200,000 (1976 dollars), as indicated in Table 3-13. Renton operation and maintenance would cost $5,950,000 per year. The effect of this on user charge is noted in the primary impact section, since user charges are determined on a Metro-wide basis. Impact of cost would be adverse, moderate, long-term, irreversible and definite.

Social, recreational and cultural. The secondary beneficial impact from improved wet weather management on swimming and boating is considered to be minor and of limited extent (primarily for Lake Washington) but long-term and important.

Mitigation Measures

Several mitigation measures are suggested to aid in the reduction of adverse impacts resulting from the implementation of this alternative.

An improved chlorine feed system can be designed to prevent chlorine levels in the Alki, Carkeek Park, and Richmond Beach sewage treatment plant effluent from exceeding dangerous levels. This could be achieved by matching chlorine levels to effluent discharge, and/or installing a chlorine contact tank, which would maximize the effectiveness of chlorination treatment. Currently chlorine is injected into the effluent flow at a constant rate, manually adjusted on a daily basis. Hourly variations in flow cause a fluctuating chlorine residual. Control of chlorine residuals at West Point could be achieved by installing a chlorine contact tank.

Pretreatment of industrial wastes could be provided before sewage enters the West Point plant. If current practices continue, influent flows at these facilities would occasionally contain slugs of cadmium, mercury, and arsenic.

Under this alternative, a mitigation measure for controlling solid and metal loads in effluent water would be to use the enhanced primary treatment of alum or other chemicals year round.

Visual nuisance of the wastewater treatment facilities can be mitigated by (1) designing new facilities and additions to existing facilities utilizing natural geographical conditions (e.g., bluffs) and (2) landscaping the facilities.

Odor of the wastewater treatment facilities can be mitigated, in part, by not allowing the system to become anaerobic. Under anaerobic conditions, noxious gases such as methane and sulfur dioxide are emitted. At Alki, odor control measures independent of the remaining facilities could be implemented by Metro.

The energy impact can in part be defrayed by using more of the methane gas which is produced by anaerobic digestion. Nearly half of this methane gas is flared off under current practices. However, it would have to be determined whether methane storage and/or transport facilities would be cost-effective.

Unavoidable Adverse Impacts

Under Alternative D, the following adverse impacts would be unavoidable.

- Construction impacts
- Sludge trucking
- Primary and enhanced primary effluent - effect on water quality
- Land use changes
- Aesthetic nuisance of plant location
- Noncompliance of PL 92-500
- Operation and maintenance (O & M) and capital costs
- Energy expenditures

For greater detail regarding unavoidable adverse impacts, the reader is referred to the preceding impact analysis.

ALTERNATIVE E
SECONDARY

The description of Alternative E and its projected impacts to the year 2005 are presented in this section.

Description

Alternative E would provide secondary treatment at the West Point, Alki and Richmond Beach treatment plants. The Carkeek Park plant would function as a primary treatment plant for wet weather flows only, beginning in 1985.

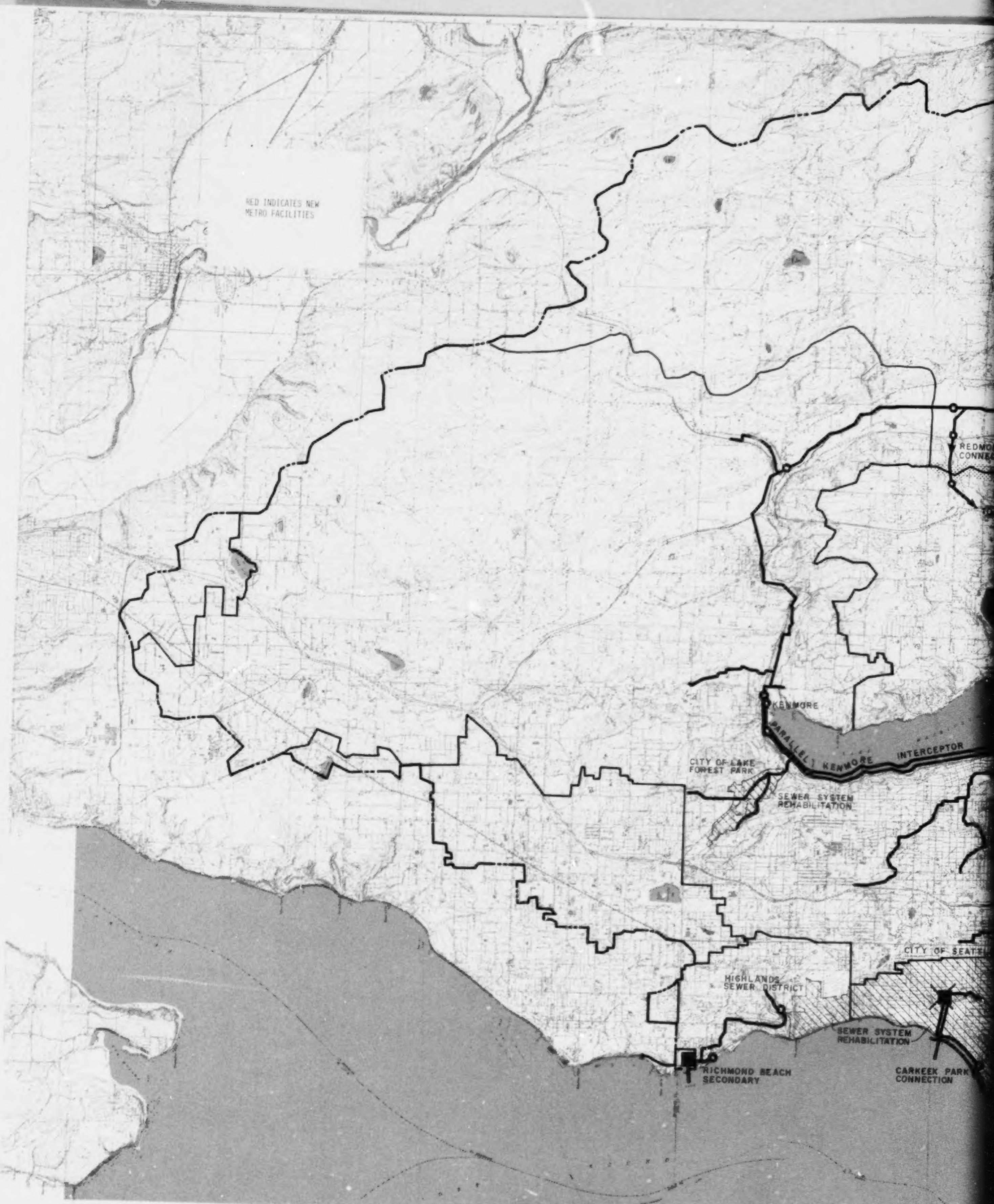
The major wastewater facilities proposed for Alternative E are illustrated in Figure 3-13. Major features of the alternative are summarized in Table 3-25, including treatment plants, effluent discharges and combined sewer overflows, and major new transfer facilities. The construction schedule and costs for proposed facilities are shown in Table 3-26.

This alternative is further described below in terms of service area, treatment plants (location, treatment process, effluent disposal site), combined sewer overflow control, and sludge management. The indirect implications on the Renton plant of the facilities proposed under this alternative are also described.

Service Area

The service areas of Alternative E are shown in Figure 3-1. The Alki and Richmond Beach service areas would not change relative to their existing areas. For West Point, the North Lake Sammamish service subarea would be transferred to Renton (as in Alternative B), the Carkeek Park service subarea for dry weather flow would be added beginning in 1985, the Val Vue area would be transferred from Renton, and increased North Lake Washington flows would be added by the Kenmore parallel.

The new transfer interceptors that would be needed to facilitate the service area modifications would be the Carkeek Park to West Point interceptor (1985), the second Kenmore (parallel) interceptor (1983) to West Point, the Val Vue transfer from Renton to West Point (1980), and the Redmond connections to Renton (1988 and 1995).


RED INDICATES NEW
METRO FACILITIES
REDMON
CONNEC
KENMORE
PARALLEL KENMORE INTERCEPTOR
CITY OF LAKE
FOREST PARK
SEWER SYSTEM
REHABILITATION
CITY OF SEATT
HIGHLANDS
SEWER DISTRICT
SEWER SYSTEM
REHABILITATION
RICHMOND BEACH
SECONDARY
CARKEEK PARK
CONNECTION

A

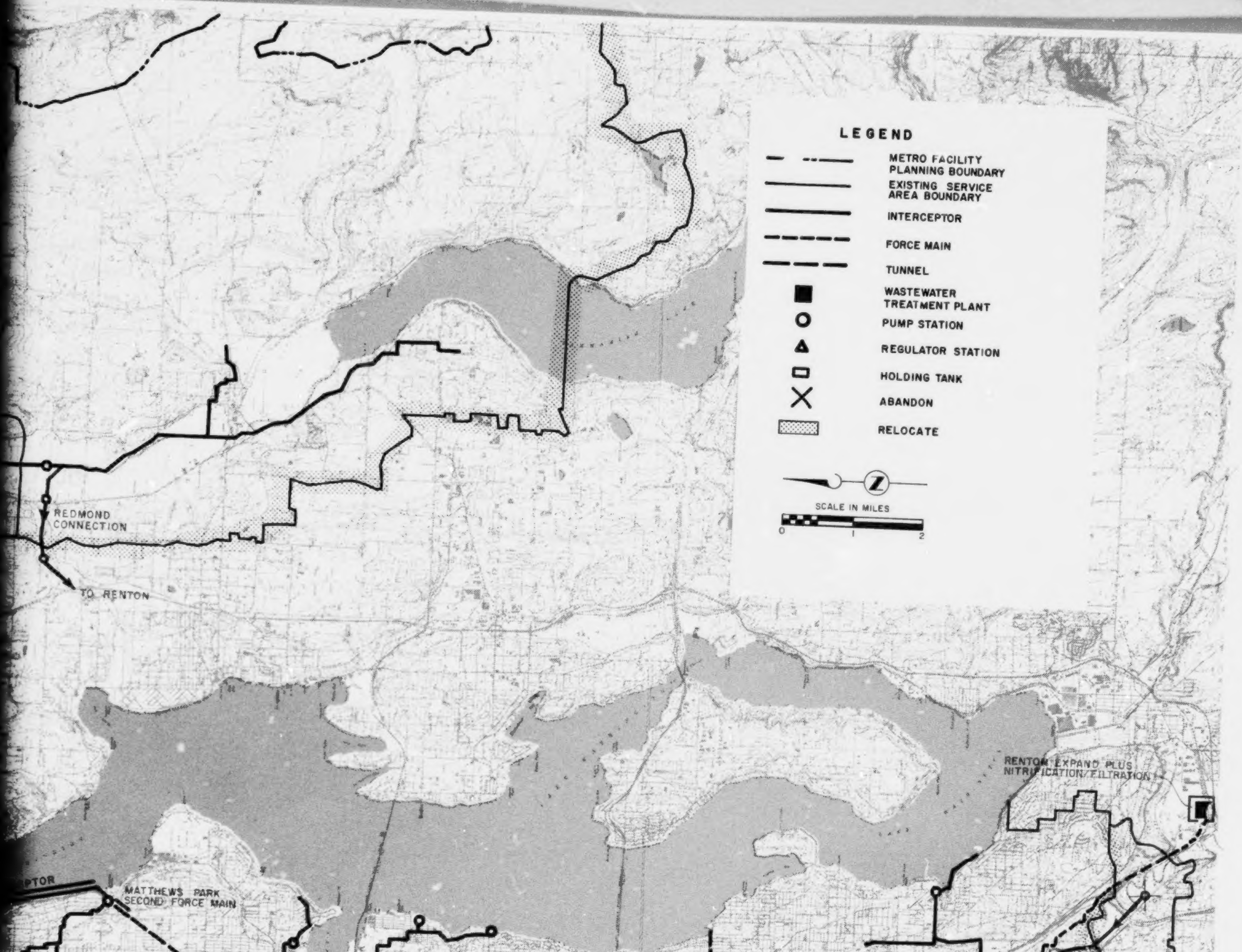

LEGEND
METRO FACILITY PLANNING BOUNDARY
EXISTING SERVICE AREA BOUNDARY
INTERCEPTOR
FORCE MAIN
TUNNEL
WASTEWATER TREATMENT PLANT
PUMP STATION
REGULATOR STATION
HOLDING TANK
ABANDON
RELOCATE
SCALE IN MILES
0
1
2
REDMOND CONNECTION
TO RENTON
RENTON EXPAND PLUS NITRIFICATION/FILTRATION
MATTHEWS PARK SECOND FORCE MAIN
MONTLAKE
VAL VUE CONNECTION
OF SEATTLE
THIRD AVE. W.
PARK
WEST POINT SECONDARY
ALKI SECONDARY

Figure 3-13
Facility Plan Alternative E — Secondary

B

TABLE 3-25

ALTERNATIVE E - SECONDARY

SUMMARY

TREATMENT PLANTS

	WEST POINT	ALKI	CARKEEK PARK		RICHMOND BEACH	RENTON*
			Phase I	Phase II		
Process	Secondary	Secondary	Primary	Primary (Wet weather)	Secondary	Secondary + Nitrification and Filtration
Improvement Complete	1985	1983	1981	1985	1981	1995
Flow (mgd) 2005 (unless phased) average/peak	145.5/350	10/30	3.5/20	0/20	2.5/8	86/223
Disposal	Puget Sound	Puget Sound	Puget Sound	Puget Sound	Puget Sound	Duwamish

COMBINED SEWER OVERFLOW (2005)

	FLOW (Million Gallons/Yr)	SOLIDS (Tons/Yr)	BOD (Tons/Yr)
Lake Washington	23.0	20.9	5.72
Lake Sammamish	0	0	0
Portage Bay	232	247	60.8
Lake Union	58.1	52.7	14.4
Ship Canal	261	236	64.9
Elliott Bay	358	325	89
Alki Beach	5.46	4.95	1.36
Duwamish/Green River	251	227	62
TOTAL	1188.6	1113.6	298.2

TREATMENT PLANT DISCHARGE

	FLOW (Million Gallons/Yr)	SOLIDS (Tons/Yr)	BOD (Tons/Yr)
West Point	57,900	3,600	3,600
Alki Beach	3,650	228	228
Carkeek Park	0	0	0
Richmond Beach	912	57.1	57.1
Renton	31,350	663	1,308
TOTAL	93,812	4,548	5,193

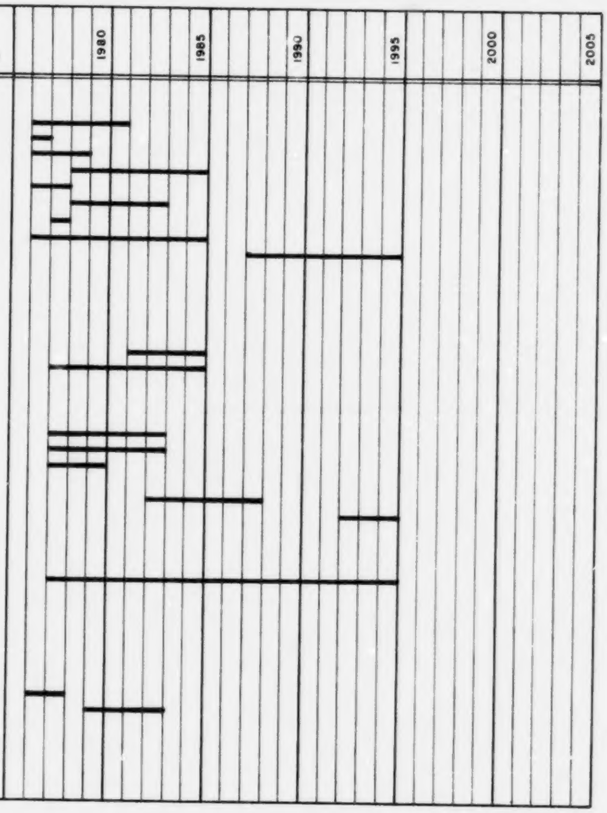
Location	Year Completed
Carkeek to West Point Interceptor	1985
Second Kenmore Interceptor	1983
Val Vue Transfer (from Renton)	1980
Redmond Connection - Main Project	1988
Redmond Connection - Additional Capacity	1995

*Not included in proposed facilities plan for Puget Sound plants

TABLE 3-26

Alternative E -- Project Costs and Construction Staging

Facility Component	Project Cost $ Million ENR-CCI - 2600
Treatment Plants	
Richmond Beach Secondary	6.0
Carkeek Park Interim Improvements	0.1
West Point Interim Improvements	4.8
West Point Secondary Treatment	115.2
Alki Interim Improvements	0.3
*Alki Secondary Treatment	26.2
*Renton Interim Improvements	0.4
*Renton Enlargement II and Upgrading	65.5
Renton Enlargement III	46.0
Subtotal - Treatment Plants	264.5
Collection System	
Accommodate Carkeek Abandonment	7.4
Rehabilitation of Existing	18.0
Increased Transfer Capacity Within West Point Existing Sewered Areas	
Second Kenmore Interceptor	22.2
Kenmore P.S. (Permanent)	8.5
Val Vue Transfer (from Renton)	5.5
Redmond Connection (to Renton)	
Main Project	14.0
Additional Capacity	1.0
*Increased Transfer Capacity and Rehabilitation within Renton Existing Sewered Areas	27.3
Subtotal - Collection System Except CSO, Extensions	103.9
Combined Sewer Overflow Control	
Montlake Regulator Station	0.8
Third Avenue West Regulator Station	0.5
Subtotal - Hold and Transport CSO	1.3
Total Capital Cost	369.7



*Renton facilities are not part of the proposed facilities plan.

Construction schedule for these collection system modifications would be as in Table 3-26.

Treatment Plants

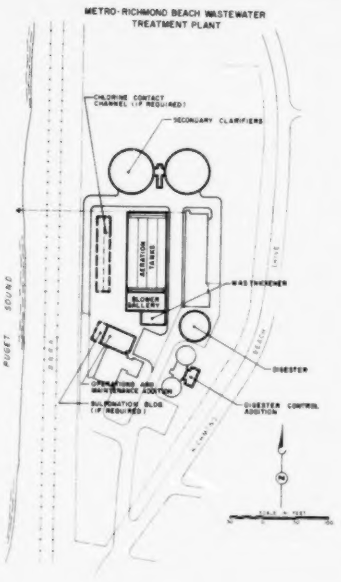
The wastewater treatment facilities under Alternative E are shown in Table 3-25. The West Point, Alki and Richmond Beach plants would be upgraded to secondary treatment by the air activated sludge processes for improved removal of suspended solids, oxygen-demanding materials, and other parameters. These improvements would be completed by 1981 at Richmond Beach, 1983 at Alki and 1985 at West Point. Chlorine contact and dechlorination facilities are identified and costed, should such facilities be mandated.

At Carkeek Park, interim improvements would be completed by 1981 to allow implementation of local sewer rehabilitation. The Carkeek Park plant would continue to provide primary treatment to both dry and wet weather flow until 1985. At that time, the Carkeek Park plant would continue to provide primary treatment to wet weather flow, but dry weather flow would be transferred to West Point. The Carkeek Park plant could be abandoned, probably in 1995 (depending on the City of Seattle sewer separation program).

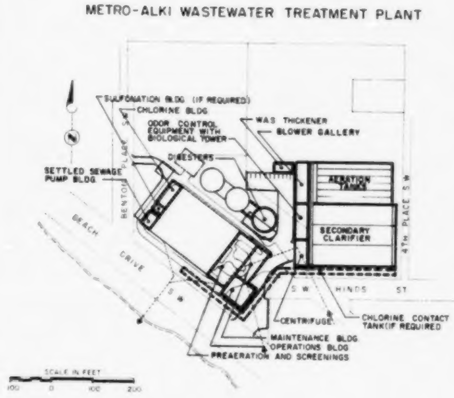
The proposed plant layouts are shown in Figure 3-14. The existing plant property at Richmond Beach could accommodate secondary treatment. At Alki, expansion of the plant boundaries into the adjacent ballfields would be necessary for the secondary clarifiers. No changes in the area at Carkeek Park are needed. Air activated sludge at West Point would require 12 acres of shoreline fill for the aeration tanks and secondary clarifiers. (An option that would require less area at West Point would be secondary treatment with tower trickling filters rather than activated sludge, but this is not the proposed option in the Draft Facility Plan and is not included in the costs. Therefore, its impacts are not described in the Draft EIS.)

The dry weather plant capacity at West Point would increase by 3.5 million gallons per day (mgd) relative to Alternative B, due to the added flows from Carkeek Park. The Alki and Richmond Beach plant capacities would be as in Alternative B because no service area modifications are planned.

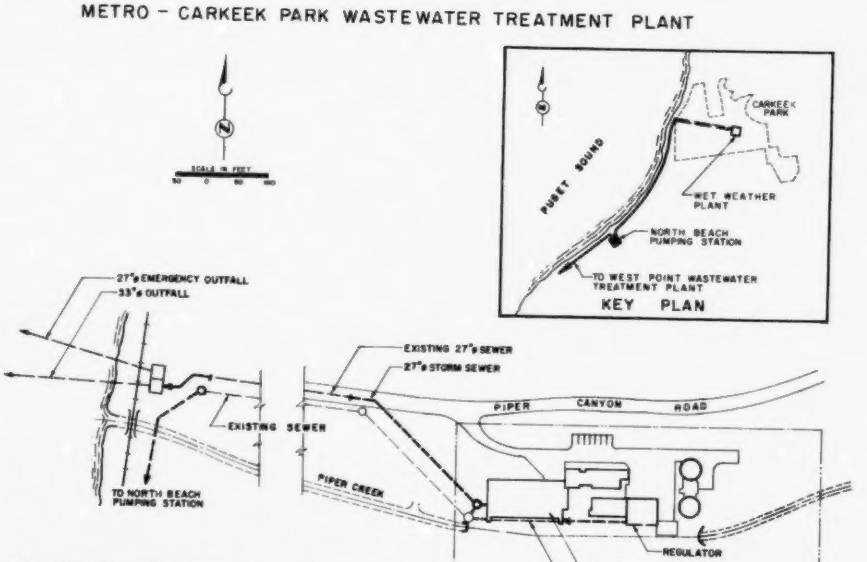
Treated secondary effluent would be discharged to Puget Sound from the existing outfalls at West Point, Alki and


METRO-RICHMOND BEACH WASTEWATER TREATMENT PLANT
CHLORINE CONTACT CHANNEL (IF REQUIRED)
SECONDARY CLARIFIERS
AERATION TANKS
BLOWER GALLERY
WAS THICKENER
DIGESTER
OPERATIONS AND MAINTENANCE ADDITION
SULFONATION BLDG (IF REQUIRED)
DIGESTER CONTROL ADDITION
PUGET SOUND
BEACH DRIVE
N
SCALE IN FEET

SECONDARY

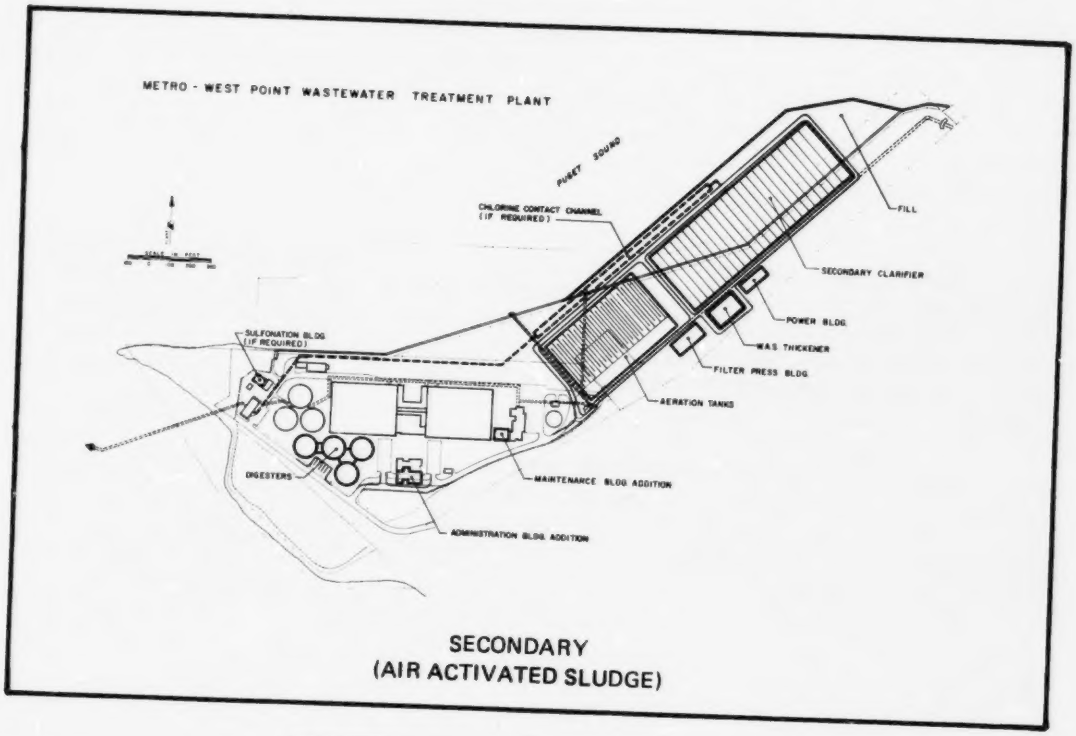

METRO-ALKI WASTEWATER TREATMENT PLANT
SULFONATION BLDG (IF REQUIRED)
CHLORINE BLDG
ODOR CONTROL EQUIPMENT WITH BIOLOGICAL TOWER
WAS THICKENER
BLOWER GALLERY
DIGESTERS
SETTLED SEWAGE PUMP BLDG
AERATION TANKS
SECONDARY CLARIFIER
BENTON PLACE S.W.
BEACH DRIVE S.W.
47TH PLACE S.W.
S.W. HINDS ST
CENTRIFUGE
CHLORINE CONTACT TANK (IF REQUIRED)
MAINTENANCE BLDG
OPERATIONS BLDG
PREAERATION AND SCREENINGS
N
SCALE IN FEET
100
0
100
200

SECONDARY


METRO - CARKEEK PARK WASTEWATER TREATMENT PLANT
N
SCALE IN FEET
50
0
50
100
CARKEEK PARK
PUGET SOUND
WET WEATHER PLANT
NORTH BEACH PUMPING STATION
TO WEST POINT WASTEWATER TREATMENT PLANT
KEY PLAN
27"ø EMERGENCY OUTFALL
33"ø OUTFALL
EXISTING 27"ø SEWER
27"ø STORM SEWER
PIPER CANYON ROAD
EXISTING SEWER
PIPER CREEK
TO NORTH BEACH PUMPING STATION
REGULATOR
WET WEATHER PLANT ONLY
EXISTING PLANT BYPASS

ABANDON (INTERIM, WET
WEATHER PLANT)

Figure 3-14
Alternative E – – Plant Layouts, (Sheet 1)


METRO - WEST POINT WASTEWATER TREATMENT PLANT
PUGET SOUND
CHLORINE CONTACT CHANNEL (IF REQUIRED)
FILL
SECONDARY CLARIFIER
POWER BLDG
WAS THICKENER
FILTER PRESS BLDG
AERATION TANKS
SULFONATION BLDG (IF REQUIRED)
DIGESTERS
MAINTENANCE BLDG ADDITION
ADMINISTRATION BLDG ADDITION
SCALE IN FEET

SECONDARY
(AIR ACTIVATED SLUDGE)

Figure 3-14
Alternative E – – Plant Layouts (Sheet 2)

Richmond Beach. The Carkeek Park outfall would discharge primary treated storm water.

Combined Sewer Overflow Control

In Alternative E, combined sewer overflow volumes would increase by two to three percent, relative to Alternative B, to Lake Washington, Portage Bay, Lake Union, and the Ship Canal. The current program of maximizing available in-line storage capacity for control of combined sewer overflows would be continued by construction of the Montlake and Third Avenue West regulator stations. Excessive infiltration/inflow would be removed from the Highlands, Carkeek Park, City of Seattle, and City of Lake Forest Park service areas.

Sludge Management

Additional sludge digestion facilities would be required at West Point, Alki, and Richmond Beach to handle the increased solids produced by secondary treatment. Anaerobic treatment would be used for sludge digestion; the methane gas produced would be used to the extent possible at each site.

Richmond Beach digested sludge would be trucked to West Point for dewatering. Dewatered sludge from Alki and West Point would be trucked to Cedar Hills landfill and Pack Forest. Renton sludge would be handled at Renton rather than West Point.

Renton

Although the Renton service area and treatment plant are not included in the proposed facilities for Alternative E, the alternative would have indirect impacts on the Renton plant. The service area for Renton would be increased as the West Point service area is reduced. The treatment plant would be enlarged to service growth in two stages (completed in 1985 and 1995) up to an average capacity of 86 mgd (223 mgd peak). Nitrification and filtration (following secondary treatment) and dechlorination would improve effluent quality before discharge to the Duwamish River. Sludge would be treated by anaerobic digestion, dewatered, and trucked to the Cedar Hills landfill or Pack Forest.

Primary Impacts

The direct impacts from this alternative for the Puget Sound plants are described below in terms of effects on geology, soils and topography; air quality and odors; water quality; biology; energy and natural resources and the human environment. Indirect impacts from this alternative and the effects of Renton discharge are summarized under a later section on secondary impacts.

Geology, Soils and Topography

Alternative E includes substantial site expansions at the West Point, Alki and Richmond Beach sites to accommodate secondary treatment. Shoreline fill, which may locally affect microcurrents and sediment transport, is included at West Point. Since the impacts are site-specific, they are described in Volume II of the EIS series for West Point, Alki, and Richmond Beach.

The effects of the Kenmore Parallel Interceptor, to be constructed under this alternative, are considered to be of potential regional significance since salmon spawning areas in Lake Washington could possibly be affected. Impacts for geology, topography and soils from this construction could involve siltation, accelerated erosion and seismic risk, as described under Alternative B. Impacts would continue at existing sludge disposal sites. Since the amount of sludge from secondary treatment would be approximately twice that from primary treatment, this alternative could reduce the 30 year useful lifetime of the Cedar Hills landfill by about one year if all sludge were disposed of there.

Construction waste disposal sites may be subject to alterations in topography or soils, but these limited impacts would depend on the sites, which have not been selected.

Air Quality and Odors

Sludge trucking traffic from West Point and Alki to the Cedar Hills landfill would emit approximately 415 grams of hydrocarbons, 2585 grams of carbon monoxide and 1880 grams of nitrogen oxide per day. Operating personnel traffic to wastewater treatment plants would generate approximately 5190 grams of hydrocarbons, 66,010 grams of carbon monoxide and 8550 grams of nitrogen oxide per day. The combined emissions would be less than 0.01 percent of Seattle's total daily emissions of hydrocarbons, carbon monoxide, and nitrogen oxides. The air pollutants emitted under this alternative would have a negligible, long-term, adverse, reversible impact on the air quality of the Seattle area.

Upgrading the Richmond Beach, Alki, and West Point plants to secondary treatment increases the possibility of odors escaping in these areas. Because secondary treatment plants are larger and more complex than primary plants, expose more water surface area to the air and subject the water to more perturbation, there is a greater likelihood for odors being released into the surrounding neighborhood from secondary treatment plants. Various practical measures can be employed, however, to control treatment plant odors and are discussed in the section on mitigation measures. Abandoning the Carkeek Park plant (probably by 1995) would reduce the potential for odor problems in the Carkeek area. The slight increase of CSO's into Lake Washington, Lake Union, and the Ship Canal will increase the potential for odors from CSO's in these areas. The potential for odor problems associated with this alternative could be said to have an adverse, long-term, reversible, minor impact on the environmental quality of the Seattle area.

Water Quality

Upgrading the West Point, Alki and Richmond Beach plants, potential phasing out the Carkeek Park plant, and allowing combined sewer overflows to continue would produce mixed beneficial and adverse effects on water quality. Principal areas of interest are Lake Washington, Lake Union/Ship Canal, Duwamish Estuary and Puget Sound.

Lake Washington. The principal impacts on Lake Washington would result from continued combined sewer overflows (CSO's), which would increase from a 1975 level of 16 million gallons per year to a 2005 value of 23 million gallons per year. This alternative would represent a 3 percent increase over the baseline Alternative B. The adverse impacts on bacterial counts along the western shore beaches, changes in temperature and turbidity, and persistent accumulation of toxicants, heavy metals and nutrients would be approximately the same as for Alternative B.

Similarly, the construction of the Kenmore Parallel could possibly have significant effects limited in extent to nearshore waters, but possibly of long duration on water quality in Lake Washington from increased turbidity, disruption of sediments, introduction of metals, hydrocarbons and other materials and resuspension of nutrients and chemicals in the sediment (as described under Alternative B).

Lake Union/Ship Canal. Combined sewer overflows and loads to Lake Union and the Ship Canal would increase by 2 to 3 percent relative to Alternative B. As described earlier for Alternative B, the effects would probably be minor since the Ship Canal is well flushed and regularly dredged.

Other freshwaters. Lake Sammamish water quality would not be directly affected by this alternative.

Duwamish estuary. Impacts from combined sewer overflows on the Duwamish estuary would be the same as Alternative B and existing conditions. The adverse effects attributed to approximately 250 million gallons per year of CSO's would be incremental and overshadowed by the 31,600 million gallons per year discharged from Renton (described under secondary impacts of this alternative).

Puget Sound. The total flow of 62 billion gallons per year under Alternative E from the wastewater treatment plants would be equivalent to the flow of Alternative B; however, the loads of suspended solids and biochemical oxygen demand (BOD) would be reduced by about 75 to 81 percent respectively. These loads would decrease relative to existing conditions by about 65 percent for solids and 75 percent for BOD. The secondary treatment process would also remove more of the potential toxicants (heavy metals, certain organic materials) and improve disinfection of bacteria and viruses relative to primary treatment. Reductions in nutrients would be small, particularly for nitrogen which can be a limiting nutrient in the Sound.

Overall, the alternative should produce a net benefit to Puget Sound water quality in two areas. First in localized areas around outfalls, the lower BOD loads could produce a small improvement in dissolved oxygen. Second, improved capability for disinfection should benefit nearshore areas and beaches by reducing bacterial counts there. These benefits, relative to Alternative B, would be long-term, reversible, and minor.

Combined sewer overflows would not be controlled to Elliott Bay or off Alki Point. Therefore potential contamination of nearshore and intertidal waters with bacteria, solids, toxicants and other materials would continue to produce minor, long-term, reversible, adverse impacts, as described in Alternative B.

Groundwater. Alternative E is not expected to exert any direct impacts on groundwater quality. The effluent from West Point, Alki and Richmond Beach wastewater facilities would be discharged into Puget Sound and thus incapable of infiltrating groundwater. Impacts at sludge disposal sites would be monitored.

Flood hazard. Floods are not expected to cause problems at any of the treatment plants in Alternative E because all of the sites are above the 100 year flood level.

Biology

The impacts of this alternative on terrestrial, shoreline and intertidal habitats; Puget Sound; the Duwamish estuary; freshwater environments; and rare and endangered species are described in this section.

Terrestrial habitats. No direct regional impacts are expected on urban terrestrial, non-urban terrestrial, forest or meadow lowland habitats. Impacts at sites are discussed in Volume II of the EIS series for West Point, Alki, Carkeek Park and Richmond Beach.

Shoreline habitats. Since combined sewer overflows to marshes and shorelines would increase 2 to 3 percent relative to Alternative B (approximately 40 percent over existing conditions), the effects from sediments, metals, oil, toxicants, organics and nutrients could have moderate, adverse, long-term, irreversible impacts. Increases in BOD and nutrients would be moderate, adverse, short-term and reversible. For more detail, see Alternative B.

Constructing the Kenmore parallel interceptor could possibly have an adverse effect on the salmon spawning areas and wildlife habitat of northwest Lake Washington. For more detail, the reader is referred to Alternative B.

The intertidal. Combined sewer overflows to Puget Sound at Alki/West Seattle and Elliott Bay would continue at the same level as Alternative B. Impacts have been described previously.

Nutrients, which appear to be implicated in increased growth rates of intertidal plants at West Point, would probably not be removed in significant amounts by secondary treatment and would therefore enter Puget Sound in increased amounts. This is considered to be a moderate adverse impact, limited on beaches, long-term and reversible. Coliform bacteria in shellfish could decrease if chlorination facilities are improved, and with the extension of the Alki outfall. Bacterial and pathogen inputs from CSO's would continue, however, and it is impossible to determine whether or not state bacterial standards for shellfish waters would be met. Better chlorination and dechlorination would also reduce the risk of occasional chlorine toxicity, for which the magnitude is unknown.

The reduction in solids, BOD, and metals is considered to be a minor limited benefit, as effects from these parameters have not been demonstrated on the intertidal. Metals levels are slightly higher near outfall areas, but below existing standards. Toxicant levels in effluents are unknown, but removals in secondary treatment would be a positive effect. The benefit of metals and toxicants removals would be long-term.

It is not known which affects the intertidal community more overall: CSO's or effluents. Effluent quality is generally fairly well known (except for toxicants and trace elements), but its frequency of contact with the intertidal is not. CSO quality, on the other hand, is poorly known, but frequency of occurrence has been evaluated.

Alternative E also includes a Carkeek-West Point Interceptor along the shore of Puget Sound and crossing Shilshole Bay. Assuming the line would be underground the disruption of the shoreline habitat would be severe but temporary and limited. The substrate could be removed and turbidity generated, similar to the effects of the Kenmore parallel on lake shores. The regional impact is judged to be minor.

Puget Sound. Secondary treatment would include improved disinfection, better kill with reduced chlorine dosage: BOD, solids, and metals and toxicant loads would be significantly reduced. Nutrient inputs would increase moderately. The extension of the Alki outfall would reduce impacts to the nearshore areas, but add nutrients to a mid-channel area where plankton blooms develop. CSO's to Puget Sound waters would be as in baseline conditions.

Nearshore and offshore phytoplankton could be affected by 35% more nutrients than at present, and the distribution of phytoplankton may be altered through extension of the Alki outfall. The probable net effect is considered to be moderate, negative, probably limited in extent to within a mile or so of outfalls, long-term and reversible. The effect on zooplankton is not determinable. Offshore free-swimming and bottom dwelling organisms would be exposed to effluents containing substantially less solids, metals and toxicants.

The apparent influence of the effluent plumes on benthic community composition would continue and increase slightly due to nutrients; effects due to solids and organic matter would decrease. The abundance of clams and worms at the 150 foot contour could become less pronounced.

The composition of fish assemblages near the outfalls may or may not change with secondary treatment. Some fishes may be attracted to the organisms on the pipe or to the pipe itself and would remain. Fishes which may be attracted by prey species favored by effluent-caused changes in the bottom or the water column may also remain, although the waters and substrates would be affected less. Any effects on fishes are transient in this area. The slightly elevated incidence of tumors on flatfish may or may not change with secondary treatment of effluent as the cause or causes of the occurrence is unknown.

The Carkeek-West Point interceptor would cross Salmon Bay, which is a critical area for migratory fish species of the Lake Washington drainage basin and supports many of the marine species found in the Seattle area. The bay is also a resting and feeding area for migratory water birds. Alternatives in the water quality due to laying of the pipe could increase migratory fish susceptibility to natural mortality and predation during the period of construction.

Other organisms which may be affected include geoduck beds, octopus, and bottomfish stocks. The impact is judged to be major but temporary, highly limited and probably reversible. The effects of reducing Carkeek to a wet weather facility are described in the site document which is Volume II of this series.

Commercial and sport fisheries. Salmonid runs up the Ship Canal through Lake Wasington would be further affected by a 40 percent increase in CSO's to those waters relative to existing conditions (2 to 3 percent increase over Alternative B), as would salmon spawning areas in the lake, due to further reductions in DO, over-enrichment of nutrients and metals and toxicants loads. Possible negative impacts are considered under Alternative B.

Herring fisheries at Alki would be exposed to baseline levels of CSO's, but the extension of the Alki outfall would provide a benefit in that effluent would reach the beaches less often or not at all, depending on design.

Juvenile herring and salmonids feeding in eelgrass beds and other nearshore areas occasionally affected by effluents benefit somewhat by the decrease in toxicants and metals loadings which could build up in time in their prey. With improved chlorination and dechlorination, the possibility of chlorine toxicity would probably be elimianted. The benefit is considered to be minor-to-moderate, and long-term as effluent flows and CSO's would continue.

The Duwamish estuary. Overflows to the Duwamish would continue at baseline levels, as described under Alternative B. Since CSO's would represent 0.8, 34, and 5 percent of Renton flow, solids, and BOD, the impacts of CSO's (except for localized areas) would be small in comparison.

Freshwater environments. Alternative E would affect freshwaters by increasing combined sewer overflows to Lake Washington and Lake Union/Ship Canal.

1. Lake Washington. CSO's to Lake Washington would increase about 2 to 3 percent over Alternative B; minor effects would be similar to those described for Alternative B.

2. Lake Union/Ship Canal. The impacts of combined sewer overflows would be approximately the same as for Alternative B.

3. Lake Sammamish, Sammamish River, Cedar River, Green River, other freshwaters. No impacts are expected.

4. Rare and endangered species. No rare or endangered species are recorded from the study area.

Energy and Natural Resources

Energy and chemical consumption are summarized in Table 3-27.

Energy. For Alternative E, a net of 87 million equivalent kwh/year of energy would be consumed in 2005 by the Puget Sound plants. Included in this would be 86 million kwh/year of purchased electrical energy. This is equivalent to the amount of electrical energy 4300 households would consume per year, and constitutes approximately 0.43 percent of the projected electrical energy consumption of Seattle in 2005 (see Appendix E).

Table 3-27 shows the breakdown of total energy consumption on a plant-by-plant basis. The greatest energy consumption would be in the form of electricity. Chemicals account for about 5-25 percent of energy consumption, and sludge trucking for less than 5 percent. In the anaerobic digestion of sludge, there is a net production of energy because of methane formation.

The impact of the energy consumption would be adverse, moderate in magnitude, long-term, irreversible, and definite.

Chemicals. Annual chlorine consumption would be a total of 2350 tons/year at all facilities. Lime and ferric chloride would be used at West Point, with annual consumption of 2975 and 520 tons, respectively. At Alki, 5 tons/year of polymer would be consumed.

The impact of chemical usage would be adverse, minor, long-term, irreversible, and definite. The supplies of chlorine and polymer are highly reliable; lime and ferric chloride are in moderate supply.

Sulfur dioxide (710 tons per year) would be used to dechlorinate effluent water.

Human Environment

Alternative E has many beneficial impacts on the human environment.

Land use. Major land use changes would include expansion

TABLE 3 - 27

ENERGY AND CHEMICAL CONSUMPTION FOR ALTERNATIVE E

	PLANT				
	Richmond Beach	Carkeek Park	West Point	Alki	Total
Onsite Energy					
Purchased electricity (kwh x 10^6/yr)	2.20	0.46	77.25	6.07	85.98
Produced by digestion (kwh x 10^6/yr)	0.42	-	20.00	1.28	21.7
Consumed by digestion (kwh x 10^6/yr)	0.17	-	8.00	0.51	8.68
Offsite Energy					
Chemicals (kwh x 10^6/yr)	0.12	-	12.47	0.59	13.18
Sludge Trucking (kwh x 10^6/yr)	0.10	-	1.19	0.03	1.32
TOTAL	2.17	0.46	78.91	5.92	87.46
CHEMICAL CONSUMPTION:					
Chemicals (tons/yr)					
Cl_2	35	-	2170	145	2350
SO_2a	10	-	655	45	710
CaO	-	-	2975	-	2975
$FeCl_3$	-	-	520	-	520
Polymer	-	-	-	5	5

(a) SO_2 may be used for a mitigation measure if dechlorination is required by EPA standards.

of all existing wastewater treatment facilities except Carkeek Park (which could be phased out) and rights-of-way for the following interceptors: Redmond connection, Val Vue connection, Carkeek Park connection, and Kenmore parallel interceptor. In addition, land would have to be made available for the Montlake and Third Avenue West regulator stations, and the Kenmore pumping station. If the Carkeek Park connection, the North Creek-Hollywood connection, and the Kenmore CSO holding tank or pumping station are within 200 feet of the shoreline (of Puget Sound or Lake Washington) permits would have to be obtained from the Shorelines Management Master Program (SMMP) for Seattle and King County. These land use impacts during construction would be adverse, moderate, short-term, reversible and definite.

Expansion at the West Point, Carkeek Park and Richmond Beach facilities would also depend on these SMMP permits (at Richmond Beach, the permit would be obtained from King County). At West Point, shoreline fill would occur. The impact of these on land uses could be adverse, moderate-to-major, long-term and irreversible.

Legal and institutional. Alternative E would fulfill the requirements of PL 92-500 and Washington NPDES regulations that secondary treatment be provided.

Timing is a matter of consideration: under the Alternative E time schedule of the Draft Facility Plan, secondary treatment would be completed in 1985. Under Section 201 of PL 92-500, secondary treatment should be completed by July 1, 1977, but it is recognized that that deadline could not be met. Now NPDES requirements for secondary treatment plant timing are dependent on completion of planning and design. Although the construction schedule shown in the Draft Facility Plan indicates all secondary treatment facilities will be completed by 1985, the EPA will require secondary treatment by 1983. A detailed compliance schedule will be developed on completion of the Facility Plan and EIS by June 30, 1978.

Permits from the Shorelines Management Master Program for Seattle would have to be obtained at any location within the Seattle city limits where construction occurs within 200 feet of shoreline, as explained under land use considerations.

Agency goals. Alternative E fulfills the King County comprehensive plans of "taking all possible steps to abate pollution" and "installing utility lines in advance of the time of development." Alternative E fulfills in part the objectives mentioned in Goals of Seattle to "undertake all means reasonable and feasible to ensure water purity to meet health standards and protect the environment. . . . to meet the goals of PL 92-500, . . . and to ensure clean water to protect wildlife, vegetation, and recreation areas."

Employment. It has been estimated that the construction involved in this alternative would require the employment of approximately 350 workers until 1985. Operation and maintenance would require 115 employees at the West Point, Carkeek Park, Richmond Beach, and Duwamish facilities.

Costs. For Alternative E, the estimated capital cost for constructing new treatment facilities, collection systems, effluent disposal sites, and sludge handling and disposal facilities would be $212,800,000 (1976 dollars) (excluding Renton) as summarized in Table 3-13 (Metropolitan Engineer, 1977). This is 0.22 percent of the $95,902 billion estimated by the EPA for implementation of PL 92-500 throughout the country (EPA, 1976). The estimated operation and maintenance costs (excluding Renton) would be $8,230,000 per year, as shown in Table 3-13 (Metropolitan Engineers, 1977).

The average Metro monthly user charge per equivalent connection for the next 20 years would be $6.80 per month if all future facilities to 2005 are grant eligible, as shown in Table 3-14. User charges would be $8.00 per month if future capacity beyond 1985 is not grant eligible. They would be $12.75 per month if no future facilities are grant eligible. Since Alternative E complies with the secondary treatment requirement of PL 92-500, which is a condition for grant funding, it appears that the probable user charge would be either $6.80 or $8.00 per month, an amount $1.60 to $0.40 below the average expected user charge in Alternative B of $8.40 per month.

Impact of cost would be adverse, moderate, long-term, irreversible, and definite.

Social, recreational and cultural. As surveyed by HRPI, 54 to 64 percent of the people interviewed in districts adjacent to the wastewater facilities (HRPI, 1976) expressed a preference for secondary treatment as required by PL 92-500. Alternative E would fulfill that goal, which is considered beneficial, important, long-term, reversible, and would definitely occur. Impacts in the regions close to the facilities are discussed in respective site-specific documents, Volume II of the EIS.

Impacts on the parks and recreational facilities close to the West Point and Carkeek Park facilities are explained in those respective site-specific documents. Because secondary treatment would require site expansion, this alternative would eliminate a ballfield next to Alki, increase the potential for incompatibility with Discovery Park near West Point, and continue plant operation at Carkeek Park.

Since only the Montlake and Third Avenue West regulator stations and the Kenmore parallel interceptor are installed for control of combined sewer overflows, there still may be coliform levels exceeding health standards at swimming beaches along Lake Washington. This is considered adverse, major, long-term, reversible, and possible if Alternative E is implemented.

Archeological and historical. It has been determined that any archeological sites which may have occurred at West Point, Carkeek Park, Richmond Beach, and Alki would have already been destroyed by former construction; therefore, any more construction could not destroy archeological sites (Jerry Jermann, 1976). Of the historical sites listed in Appendix E, none are known to be present at proposed construction sites.

Health and safety. A negative impact could be associated with coliform bacteria violations at Lake Washington public beaches.

Another highly unlikely safety hazard is accidental leakage of chemicals when they are in transport, or handled on site. Although nearly every U.S. water and wastewater treatment facility uses chemicals, there have been very few chemical-related accidents.

The health and safety problems related to sludge transport and disposal would be as improbable as for any other trucks in transit.

Construction risks to safety would be the same as for other construction of a similar nature; they would be adverse, minor, last only for the duration of construction, may be reversible, and are unlikely.

Aesthetics and nuisance. Introducing secondary treatment at West Point, Richmond Beach, and Alki would generate some site-specific nuisance impacts for local residents as discussed in more detail in Volume II for various sites. However, surveys and public workshops have generally indicated that in the locales of these facilities "cleaning up the environment" was considered a higher priority by more people (60 percent) than such aesthetic issues as hiding the facility (6 percent) (HRPI, 1976). These aesthetic and nuisance impacts are rated as adverse, minor, long-term, reversible, and definite.

Interceptor construction would be a short-term, reversible, local, and probable nuisance, especially the Carkeek Park Connection and Kenmore parallel interceptor, which go along shoreline areas.

Secondary Impacts

The secondary or indirect impacts of the alternative would result from expanding the Renton treatment plant and population growth. The effects of these changes on water quality, biology, energy, natural resources and the human environment are described below.

Water Quality

Impacts on the Duwamish estuary and on groundwater are described.

Duwamish estuary. Under Alternative E, Renton would be expanded from 33 mgd to 86 mgd average daily flow, and from 96 mgd to 223 mgd peak flow. It would be upgraded with nitrification and filtration. At a design capacity of 86 mgd, Renton flow would equal about 60 percent of Duwamish summer low flows. The resulting flow augmentation could help alleviate temperature problems which develop in summer, but probably will not improve oxygen levels. Nutrients levels could be significantly affected by the increases in Renton effluent. Metals and toxicants inputs from Renton are expected to be minor. The net adverse impact is expected to be significant, because of the size of the discharge relative to the Duwamish flow; long-term because the increased discharge will continue through the planning period; and extensive, because pollutants from the Duwamish can affect beaches over a wide area. Impacts would be similar to those described under Alternatives C and D.

Groundwater. Impacts of population growth would be as described under Alternative B.

Biology

Secondary impacts on biology would be primarily on the Duwamish estuary as a result of the expansion of Renton. Relative to Alternative B, solids and BOD loads would decrease by about 66 and 34 percent respectively. Solids loads would be as in existing conditions, but BOD would increase. In the summer especially, temperature, nitrates, and dissolved oxygen levels in the estuary would be affected by the Renton effluents which would comprise over half the river's flow.

The increased freshwater flow would also change the salinity distribution, such that summer blooms may consist of freshwater rather than marine phytoplankton and mean better flushing of the estuary. Nitrogen inputs would be in the form of nitrates, which are not oxygen demanding as is ammonia, but which could contribute to algal productivity extremes in the estuary. The zooplankton would probably be indirectly affected but to an undetermined degree. The benthos would be further stressed by CSO's, low DO and nutrient enriched sediments. The net effect on the benthos is very probably major, negative and extensive in the estuary and of long duration with continuing flows. The effect on migratory and other fishes would also be major, adverse, extensive and of long duration due to low DO and CSO's. Waterfowl could leave if their prey species are adversely affected. The effects are considered to be reversible.

Energy and Natural Resources

Energy and chemical use are described below for the Renton plant.

Energy. For Alternative E, a net equivalent of 56 million kwh/year of energy would be consumed in 2005 at Renton, a secondary impact in this alternative. Included in this would be 49 million kwh/year of electrical energy purchased; 1 million kwh/year for sludge trucking, and 11 million equivalent kwh/year required to produce the chemicals consumed. A net of 4 equivalent kwh/year would be produced by the process of anaerobic digestion. The impact of the energy consumption would be adverse, moderate in magnitude, long-term, irreversible and definite.

Chemicals. Chlorine, lime, alum, and sulfur dioxide would be used with annual consumption rates of 1020, 7955, 1145, and 305 tons respectively. The impact of chemical usage would be adverse, moderate, long-term, irreversible, and definite. The supplies of chlorine and alum are reliable; lime is in moderate supply.

Human Environment

Secondary impacts on population and costs are summarized below.

Population. The Secondary Alternative would probably result in a slight facilitation of regional growth over the long term due to the improvement or preservation of water quality. It is concluded that such protection of water quality will contribute to the continuation of the region's current national image as a desirable place to live due to the generally high quality of the natural environment. While the specific cause-effect relationships which contribute to such impacts are difficult if not impossible to quantify, growth will tend to occur in the regions of higher environmental quality. If regions, such as Puget Sound, which presently have a relatively high environmental quality, maintain or improve these conditions, it is logical to expect that the encouragement to economic development will be greater than if they are allowed to deteriorate. This growth-related impact can be either beneficial or adverse depending on the characteristics of the development which occurs and the values of the people affected.

Costs. If Alternative E is implemented, capital costs for construction at Renton, a secondary impact, would be $157,200,000, as indicated in Table 3-13. Renton operation and maintenance would cost $5,370,000 per year. The effect of this on user charge is noted in the primary impact section, since user charges are determined on a Metro-wide basis. Impact of cost would be adverse, moderate, long-term, irreversible, and definite.

Mitigation Measures

Several mitigation measures are suggested to aid in the reduction of adverse impacts resulting from the implementation of this alternative.

Pretreatment of industrial wastes could be provided before sewage enters the West Point plants. If current practices continue, these facilities would occasionally receive slugs of cadmium, mercury and arsenic.

The possible silting over of salmon spawning beds during construction of the Kenmore parallel could be mitigated in several ways. Since chinook salmon lake spawning occurs in autumn and intragravel egg development continues until early March, construction could be timed so that activities are conducted from March through August only. This could raise construction costs. Alternatively, construction specifications, techniques and management could minimize adverse effects. More information is needed to fully evaluate the Kenmore parallel or other optional interceptor routes.

Unavoidable Adverse Impacts

Under Alternative E (Secondary), the following adverse impacts would be unavoidable:

- Construction impacts
- Sludge trucking
- Combined sewer overflows
- Land use changes
- Aesthetic nuisance of plant locations
- Operation and maintenance and capital costs
- Energy expenditures
- Chemical consumption

For greater detail regarding unavoidable impacts, the reader is referred to the preceding impact analysis.

ALTERNATIVE F
SECONDARY/SOUTHERN STRATEGY

The description of Alternative F and its projected impacts to the year 2005 are presented in this section.

Description

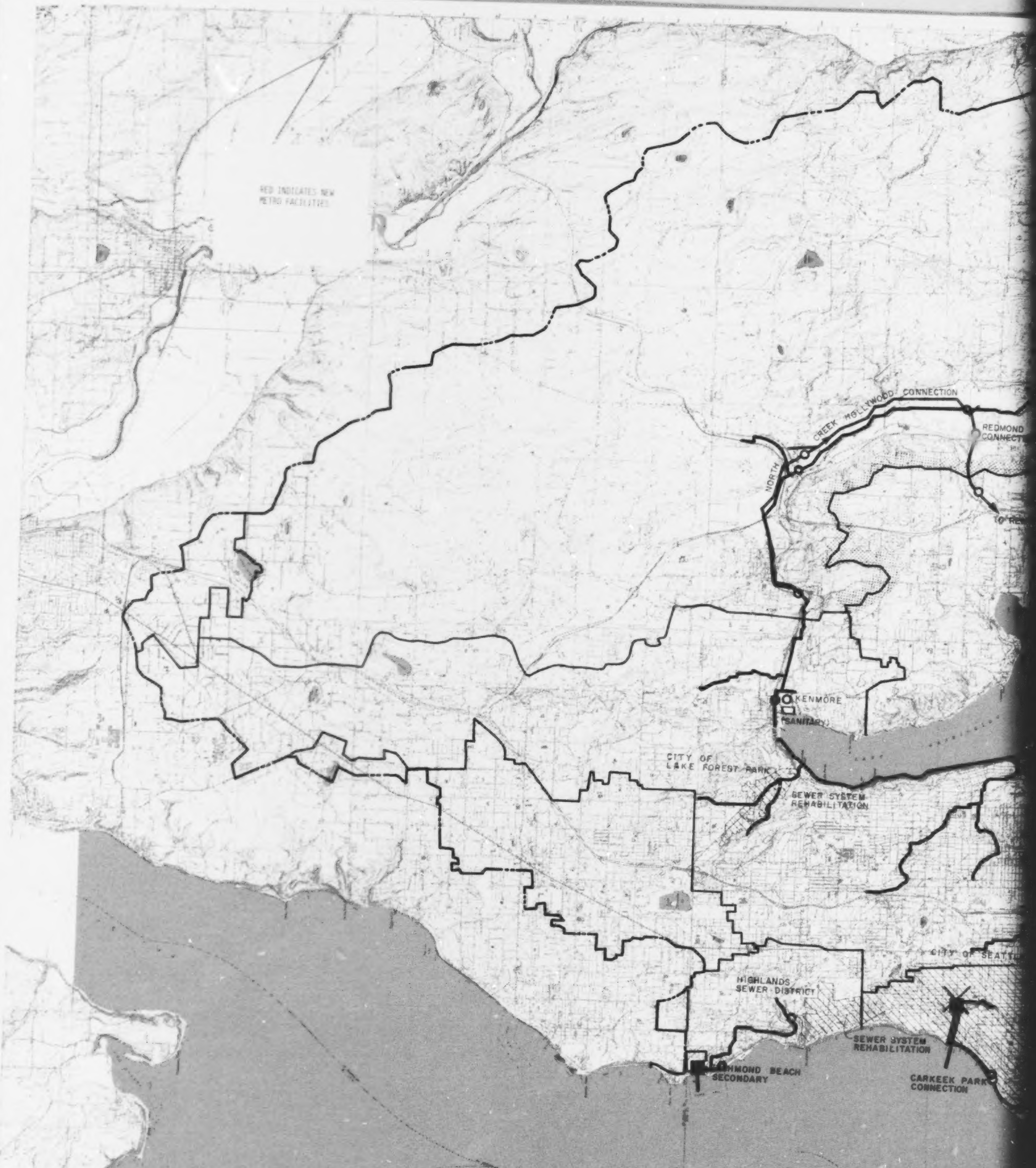
Alternative F provides secondary treatment at West Point and Richmond Beach and a new plant in the lower Duwamish to serve the southern West Point and Alki service areas, thus allowing Alki to be abandoned. Effluent from the Duwamish plant would be discharged through a new tunnel and outfall to Puget Sound off Alki Point. Renton effluent would be transferred from the Green/Duwamish River to the Duwamish site for joint disposal off Alki Point. Carkeek Park would be converted to wet weather treatment, with dry weather flows transferred to West Point.

The major wastewater facilities proposed for Alternative F are illustrated in Figure 3-15. Major features of the alternative are summarized in Table 3-28, including treatment plants, effluent discharges and combined sewer overflows, and major new transfer facilities. The construction schedule and costs for proposed facilities are shown in Table 3-29.

The alternative is further described below in terms of service area, treatment plants (location, treatment process, effluent disposal site), combined sewer overflow control and sludge management. The indirect impacts of the facilities proposed under this alternative on the Renton plant are also described.

Service Area

The service areas of Alternative F would be as shown in Figure 3-1. The Richmond Beach service area would remain as it presently exists. The West Point service area would be reduced substantially due to transfer of the southern portion of the present service area to the new Duwamish plant. Further reduction would be by transfer of the North Lake Sammamish and eastern portion of the North Lake Washington sewerage service subareas to Renton. The dry weather flow from the present Carkeek Park subarea would be added to West Point. The Duwamish plant would serve the present Alki, the


RED INDICATES NEW
METRO FACILITIES
NORTH CREEK HOLLYWOOD CONNECTION
REDMOND
CONNECT
TO RE
KENMORE
(SANITARY)
CITY OF
LAKE FOREST PARK
SEWER SYSTEM
REHABILITATION
CITY OF SEATT
HIGHLANDS
SEWER DISTRICT
SEWER SYSTEM
REHABILITATION
HMOND BEACH
SECONDARY
CARKEEK PARK
CONNECTION

A

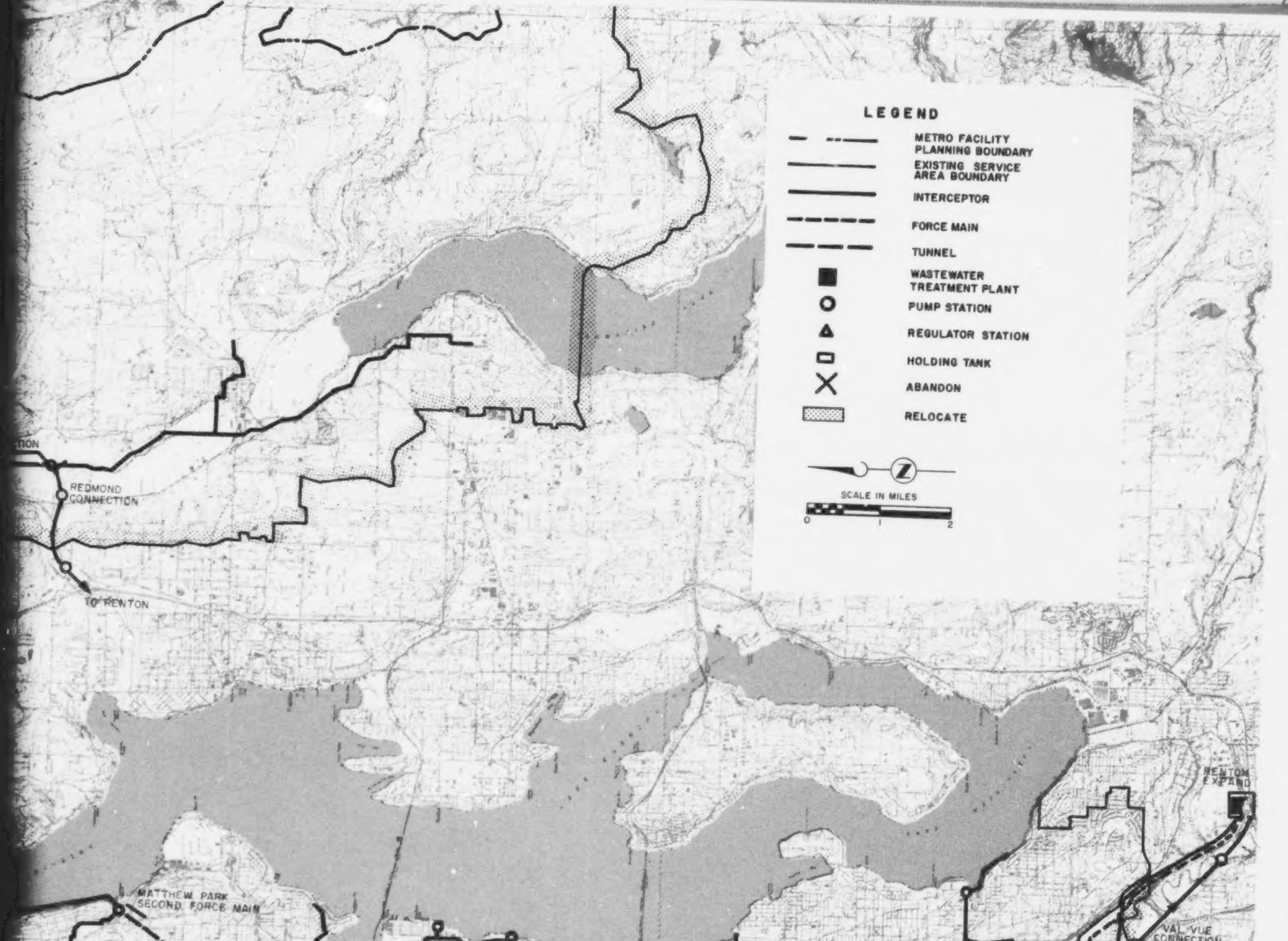

LEGEND
METRO FACILITY PLANNING BOUNDARY
EXISTING SERVICE AREA BOUNDARY
INTERCEPTOR
FORCE MAIN
TUNNEL
WASTEWATER TREATMENT PLANT
PUMP STATION
REGULATOR STATION
HOLDING TANK
ABANDON
RELOCATE
Z
SCALE IN MILES
0
1
2
TION
REDMOND CONNECTION
TO RENTON
RENTON EXPAND
MATTHEW PARK SECOND FORCE MAIN
VAL VUE CONNECTION
MONTLAKE
RENTON OUTFALL
OF SEATTLE
THIRD AVENUE WEST
DUWAMISH SECONDARY
EEK PARK
CTION
RENTON-DUWAMISH OUTFALL
ALKI CONNECTION
WEST POINT SECONDARY

Figure 3-15
Facility Plan Alternative F — —
Secondary/Southern Strategy

B

TABLE 3-28

ALTERNATIVE F - SECONDARY/SOUTHERN STRATEGY

SUMMARY

TREATMENT PLANTS

	WEST POINT	ALKI		DUWAMISH	CARKEEK PARK		RICHMOND BEACH	RENTON*
		Phase I	Phase II		Phase I	Phase II		
Process	Secondary	Primary	Abandoned	Secondary	Primary	Primary (Wet weather)	Secondary	Secondary
Improvements Complete	1985	1978	1985	1985	1981	1985	1981	1995
Flow (mgd) 2005 (unless phased) average/peak	97/350	10/30	0/0	45/145	3.5/20	0/20	2.5/8	99/259
Disposal	Puget Sound	Puget Sound	To Duwamish Plant	New Outfall to Puget Sound off Alki Point	Existing Outfall	Puget Sound Dry Weather to West Point	Puget Sound	Outfall via Duwamish Plant to Puget Sound off Alki Point

COMBINED SEWER OVERFLOW (2005)

	FLOW (Million Gallons/Yr)	SOLIDS (Tons/Yr)	BOD (Tons/Yr)
Lake Washington	15.4	14.0	3.83
Lake Sammamish	0	0	0
Portage Bay	188.8	166	40.7
Lake Union	38.9	35.3	9.68
Ship Canal	175	158	43.5
Elliott Bay	304	275	76
Alki Beach	0.15	0.14	0.04
Duwamish/Green River	251	227	62
TOTAL	973.3	875.4	235.8

TREATMENT PLANT DISCHARGE

	FLOW (Million Gallons/Yr)	SOLIDS (Tons/Yr)	BOD (Tons/Yr)
West Point	40,200	2,510	2,510
Duwamish and Renton	54,300	3,400	3,400
Carkeek Park	0	0	0
Richmond Beach	912	57.1	57.1
TOTAL	95,412	5,967	5,967

MAJOR NEW TRANSFER FACILITIES

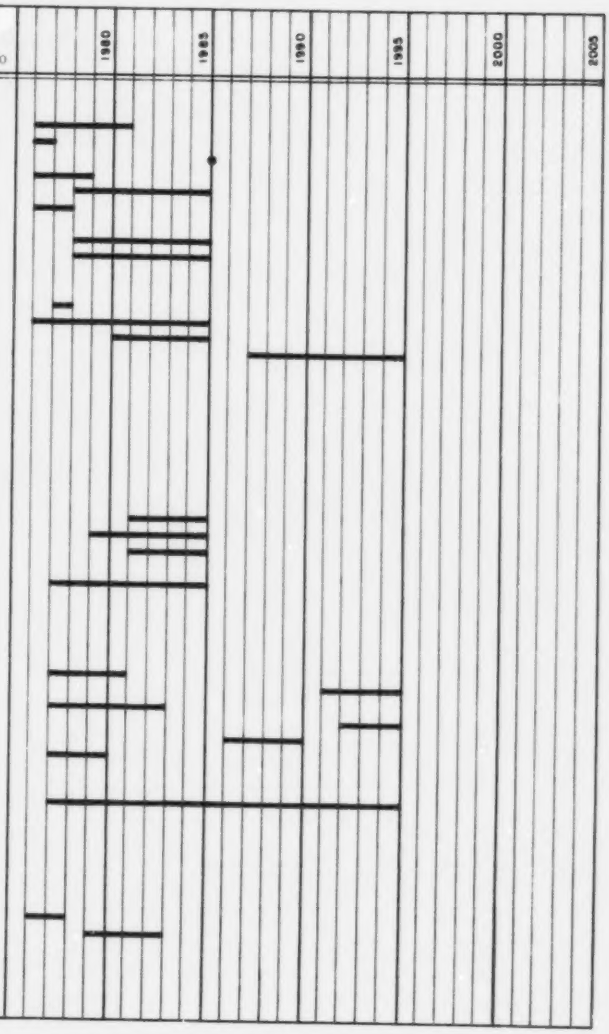
Location	Year Completed
Carkeek-to-West Point interceptor	1985
Alki-to-Duwamish interceptor	1985
Hanford-Lander Connection	1985
Redmond Connection - Stage I	1983
Redmond Connection - Stage II	1990
North Creek - Hollywood Connection	1990
Val Vue Connection (to Renton)	1980

*Not included in proposed facilities plan for Puget Sound plants

Table 3-29

Alternative F -- Project Costs and Construction Staging

Facility Component	Project Cost $ Million ENR-CCI - 2600
Treatment Plants (including outfalls)	
Richmond Beach - Add Secondary Treatment	6.0
Carkeek Park - Interim Improvements	
Carkeek Park - Abandoned	0.1
West Point - Interim Improvements	4.8
West Point - Add Secondary Treatment	81.2
Alki - Interim Improvements	0.3
Alki - Abandoned 1985	
Duwamish Secondary	115.0
Duwamish Outfall	33.8
* Renton - Includes Digestion but no Further Sludge Handling	
* Renton Interim Improvements	0.4
* Renton - Enlargement II	46.2
* Renton - Outfall to Duwamish Plant	38.5
* Renton - Enlargement III	48.1
Subtotal - Treatment Plants Including Outfalls	374.4
Collection System	
Accommodate Plant Abandonment	
Carkeek Park Connection (to North Int., P.S. at North Beach)	7.4
Alki Connection (to Duwamish)	4.2
Hanford-Lander Connection	2.4
Rehabilitation of Existing Collection System ($0.2 million Richmond Beach System; Rest West Point and Duwamish Systems)	18.0
* Increased Transfer Capacity Within West Point Existing Sewered Areas	
Kenmore P.S. (Permanent)	2.8
Holding Tank - Kenmore P.S.	5.1
Redmond Connection - Stage 1	17.0
Redmond Connection - Stage 2	3.0
North Creek - Hollywood Connection	8.0
Val Vue Connection (to Renton)	7.8
Increased Transfer Capacity and Rehabilitation within Existing Renton Sewered Areas	27.3
Subtotal - Collection System Except CSO, Extensions	103.0
Combined Sewer Overflow Control	
Montlake Regulator Station	0.8
Third Ave. W. Regulator Station	0.5
Subtotal - Hold and Transport CSO	1.3
Total Capital Cost	478.7



*Renton facilities are not part of the proposed facilities plan.

southern part of the Elliott Bay and southwest Lake Washington subareas for both dry weather and wet weather treatment.

The new transfer interceptors that would be needed to facilitate the service area modifications would be the Carkeek to West Point transfer (1985), Alki to Duwamish transfer (1985), Hanford Lander connection (1985), Redmont connections to Renton (1983 and 1990), North Creek-Hollywood connection to Renton (1990) and Val Vue connection to Renton (1980).

The construction schedule for these collection system modifications would be as in Table 3-29.

Treatment Plants

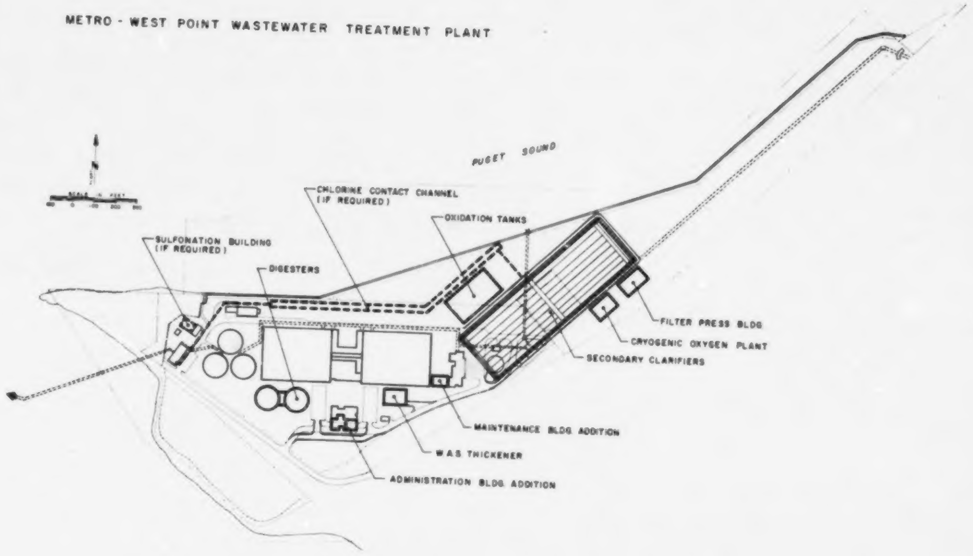
The wastewater treatment facilities under Alternative F would be as shown in Table 3-28. Secondary treatment would be provided at West Point, Richmond Beach and the new Duwamish plant. Plant layouts are shown in Figure 3-16.

At West Point, flow would be reduced due to decreases in the service area. With oxygen activated sludge, secondary treatment can be added to the existing plant site by 1985 with no shoreline fill required. (Optional air activated sludge, which would require more land, including fill is not included as the proposed option in the Draft Facility Plan and is not analyzed in the draft EIS). Secondary effluent would be discharged through the existing outfall to Puget Sound following dechlorination. The plant layout would be as shown in Figure 3-16.

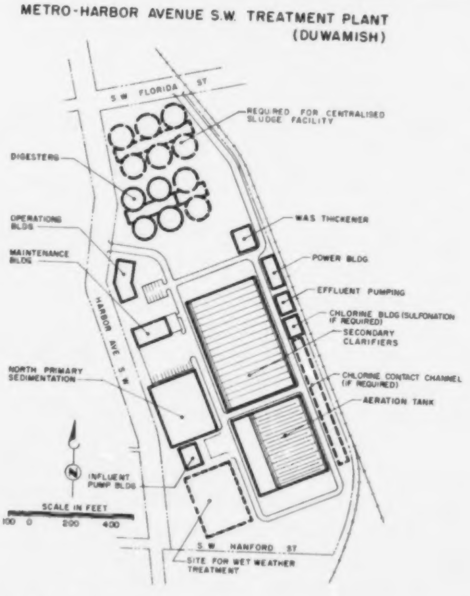
At Richmond Beach, the plant capacity would be as in Alternative B, since no changes to the service area are proposed. Secondary treatment by activated sludge and dechlorination would be provided at the existing site by 1981 with no shoreline fill. Effluent would be discharged to Puget Sound by existing outfall. The plant layout would be identical to that shown in Alternative E Figure 3-14.

The new Duwamish plant, to be completed in 1985, would provide air activated sludge secondary treatment and dechlorination for 45 mgd dry weather and 145 mgd wet weather capacity by 1985. Through a connection to Alki, the secondary effluent would be discharged through a new outfall to be constructed off Alki Point. The Renton plant effluent would also be discharged, through a connection to the Duwamish site, through this new outfall.

Several alternatives were considered in the facilities


METRO - WEST POINT WASTEWATER TREATMENT PLANT
PUGET SOUND
SCALE IN FEET
CHLORINE CONTACT CHANNEL (IF REQUIRED)
OXIDATION TANKS
SULFONATION BUILDING (IF REQUIRED)
DIGESTERS
FILTER PRESS BLDG
CRYOGENIC OXYGEN PLANT
SECONDARY CLARIFIERS
MAINTENANCE BLDG ADDITION
W.A.S. THICKENER
ADMINISTRATION BLDG ADDITION

SECONDARY — — OXYGEN ACTIVATED SLUDGE


METRO-HARBOR AVENUE S.W. TREATMENT PLANT (DUWAMISH)
S.W. FLORIDA ST
REQUIRED FOR CENTRALISED SLUDGE FACILITY
DIGESTERS
WAS THICKENER
OPERATIONS BLDG
MAINTENANCE BLDG
POWER BLDG
EFFLUENT PUMPING
HARBOR AVE S.W.
CHLORINE BLDG (SULFONATION IF REQUIRED)
SECONDARY CLARIFIERS
NORTH PRIMARY SEDIMENTATION
CHLORINE CONTACT CHANNEL (IF REQUIRED)
AERATION TANK
N
INFLUENT PUMP BLDG
SCALE IN FEET
100 0 200 400
S.W. HANFORD ST
SITE FOR WET WEATHER TREATMENT

SECONDARY — — AIR ACTIVATED SLUDGE

Figure 3-16
Alternative F — — West Point and Duwamish Plant Layouts

planning process for the Duwamish plant site. The proposed site is at Harbor Avenue, S.W. as shown in Figure 3-16, but other possibilities are still being considered. The draft EIS will use the Harbor Avenue site as the alternative for impact analysis.

At Alki, interim improvements would be made in 1981. The plant would continue to provide primary treatment until 1985, when it would be abandoned. Both wet and dry weather flow would be transferred to the new Duwamish plant for treatment and disposal off Alki.

At Carkeek Park, interim improvements in 1981 would be followed by conversion of the plant to primary treatment of wet weather flows only in 1985. Dry weather flows would be transferred to West Point by the North Beach pumping station and new transfer interceptor for secondary treatment and discharge off West Point. The plant layout would be as in Alternative E, shown in Figure 3-14.

Combined Sewer Overflow Control

In Alternative F, combined sewer overflows would be reduced by about 17 percent in the study area, relative to Alternative B. Lake Washington, Portage Bay, Lake Union, Ship Canal and Elliott Bay would have CSO flows reduced by 15 to 31 percent. CSO's at Alki would be virtually eliminated. No reduction in CSO's to the Duwamish River would occur.

The current program of maximizing available in-line storage capacity for control of combined sewer overflows would be continued by construction of regulator stations at Montlake and Third Avenue West. A combination of reduced northern service area, and increased southern service area peak capacity at the Duwamish Plant would also reduce current overflow levels.

(More CSO control is an option for this alternative depending on larger sizes for treatment plants, especially the Duwamish plant, but is not part of the proposed alternative in the Draft Facility Plan.)

Sludge Management

The sludge management system for Alternative F would include sludge digestion at West Point, Richmond Beach, Carkeek Park and Duwamish sites to handle the additional solids loads from secondary treatment. Anaerobic digestion would stabilize sludge, with methane used to the extent possible at each site. Richmond Beach digested sludge would be trucked to West Point for dewatering. Dewatered sludge from West Point and Duwamish would be trucked to Cedar Hills landfill and Park Forest, although other sludge transport opportunities are available at Duwamish. Renton sludge would be digested at Renton rather than at West Point.

Renton

Although the Renton service area and treatment plant are not included in the proposed facilities for Alternative F, the alternative would have indirect impacts on the Renton plant. Because service area modifications would transfer waste loads from new growth areas to Renton, the plant would be expanded in two stages (1985 and 1995) to a capacity of 99 mgd average weather (259 mgd peak). Renton effluent would be transferred to the Duwamish plant through a connection completed in 1985, and discharged with Duwamish effluent off Alki Point through a new outfall. Since the effluent would not be discharged to the more sensitive Duwamish River, treatment beyond activated sludge secondary is not included. Dechlorination would be provided. Sludge would be processed at Renton by anaerobic digestion, dewatered and trucked to the Cedar Hills landfill and Park Forest.

Primary Impacts

The direct impacts from this alternative for the Puget Sound plants are described below in terms of effects on geology, soils and topography; air quality and odors; water quality; biology; energy and natural resources and the human environment. Indirect impacts from this alternative and the effects of Renton discharge are summarized under a later section on secondary impacts.

Geology, Soils and Topography

Since Alternative F involves expansion and construction at several sites, a new Duwamish plant, and major tunnel and interceptor from Alki to the new plant, impacts on slope stability, erosion, topography and soil profile are considered. The Duwamish plant and tunnel impacts are discussed in the Alki document. The proposed alternative would have limited but long-term shoreline impacts and could cause problems from disposal of construction waste. Sludge disposal would be as in other secondary treatment alternatives, with accelerated sludge deposition rates but no substantial change in impact at the sludge disposal site, as described in the section on sludge management.

Impacts would continue at existing sludge disposal sites. Since the amount of sludge from secondary treatment would be approximately twice that from primary treatment, this alternative could reduce the 30 year useful life of the Cedar Hills landfill by about one year if all sludge were disposed of there.

Air Quality and Odors

The trucking of sludge from Richmond Beach to West Point and from West Point and Duwamish to the Cedar Hills landfill would emit approximately 425 grams of hydrocarbons, 2645 grams of carbon monoxide, and 1930 grams of nitrogen oxides daily. Treatment plant personnel traffic would emit approximately 5340 grams of hydrocarbons 67965 grams of carbon monoxide, and 8805 grams of nitrogen oxides daily. The combined emissions from sludge trucking and personnel commuting would amount to less than 0.01 percent of Seattle's total daily emissions of hydrocarbons, carbon monoxide and nitrogen oxides. The air pollutants emitted under this alternative would have a negligible, long-term, reversible, adverse impact on air quality in the Seattle area. Trucking to Park Forest would generate more air pollutants, but the overall effect on air quality would be negligible.

Upgrading the West Point and Richmond Beach plants to secondary treatment and constructing a new secondary treatment plant at Duwamish would increase the potential for odors escaping in these areas, as described under Alternative E.

Abandoning the Carkeek Park and Alki plants would eliminate the likelihood for odor problems in these areas. The decrease in CSO's to Lake Washington, Portage Bay, Lake Union, the Ship Canal and Elliott Bay would slightly decrease the occurrence of odors arising from CSO's in these areas. The potential odor problems associated with this alternative could be said to have a minor, long-term, adverse, reversible impact on the environmental quality of the Seattle area.

Water Quality

Impacts on water quality from Alternative F would result from secondary treatment at West Point and Richmond Beach, control of some combined sewer overflows by increased wet weather treatment plant capacity, construction of a new secondary treatment plant at Duwamish, abandonment of Alki and conversion of Carkeek Park to a wet weather plant.

Lake Washington. The volume, solids and BOD of CSO's to Lake Washington would be reduced 31 percent relative to the baseline, Alternative B, beginning in 1982. The benefit to water quality would be minor, due to the continued CSO discharge of 15.4 million gallons per year carrying 14 tons of suspended solids and 3.83 tons of BOD. Impacts would be limited to the waters adjacent to the four Metro overflow points to Lake Washington and of long duration because the CSO reduction will continue through the planning period (to 2005).

Lake Union/Ship Canal. Overflows to Lake Union and the Ship Canal, and their loadings of solids and BOD, would be decreased 31 percent by 2005 relative to the baseline, Alternative B. The benefit would be minor, due to the continued 214 million gallons per year (mgy) discharge from CSO's carrying 193 tons of solids and 53 tons of BOD. Impacts would extend throughout the Ship Canal and be of long duration. For nondegradable contaminants such as nutrients, toxicants, and heavy metals, impacts could be irreversible.

Other freshwaters. Alternative F would directly impact other freshwaters.

Duwamish estuary. Combined sewer overflows to the sensitive Duwamish area would continue unabated. The impacts from the discharge of heavy metals, pesticides, and some PCB's into Duwamish waters would be as described for Alternative E.

Puget Sound. The discharge of Renton and Duwamish secondary effluent through an improved outfall off Alki would substantially affect water quality in the Alki area. At a flow of 54 billion gallons per year, the discharge through the extended Alki outfall would be about 25 percent greater than the present West Point discharge. All of the effects currently caused by the West Point discharge could be assumed to occur from the Alki outfall as well. The discharge of suspended solids off Alki would increase almost three times relative to the baseline alternative, and that of BOD by almost two times. The nutrient enrichment effect observed within a mile of West Point would probably occur at Alki. Because the Duwamish and Renton service areas include considerable industry, the heavy metals and toxicant content of the Alki discharge would increase, irreversibly raising the toxicant and heavy metals concentrations in sediment off Alki. The extension of the Alki outfall and the 97 percent control of the Alki Beach CSO's would substantially improve the microbiological quality of Alki beaches.

With the addition of Renton flows, the total annual Metro treated wastewater discharge to Puget Sound of approximately 95 billion gallons compares with 37 billion gallons in 1975 and 62 million gallons in 2005 under Alternative B. However, since secondary treatment would be provided, loads of BOD and suspended solids would be reduced by 72 and 63 percent respectively compared to Alternative B (61 and 48 percent relative to 1975 levels). Therefore, benefits to Puget Sound for dissolved oxygen, toxicants, bacteria and turbidity should result from Alternative F. Impacts would be extensive and long-term.

Nutrient (nitrogen) reduction from secondary treatment would be very minor, so nutrient contributions from Metro facilities would still cause minor, adverse impacts at beach and nearshore areas.

Microbiological quality would be improved to a minor degree as in other secondary alternatives, but continued CSO's would still produce minor, limited problems on beaches. Near shore, no microbiological degradation is anticipated. The adverse impacts along beaches from continued but somewhat reduced heavy metals loadings would be minor, because metals do not reach the beaches in high concentrations. Impacts would be limited (because the metals are not known to spread over a wide area), long-term (because the discharges will continue through 2005) and irreversible (because heavy metals do not degrade but accumulate in sediments). Heavy metals would probably have no impact offshore.

CSO discharge to Elliott Bay would be 15 percent less than for Alternative B, so minor improvements in water quality should result. The 97 percent reduction of combined sewer overflows off Alki Beach would produce beneficial impacts as described under Alternative C.

Groundwater. Alternative F is not expected to exert any primary impacts on groundwater quality. The effluent from all wastewater facilities is discharged to Puget Sound and is incapable of infiltrating groundwater. Potential impacts at Cedar Hills and Park Forest sludge disposal sites would be monitored.

Flood hazard. Floods should not cause problems for any of the treatment plants in Alternative F because all of the sites are above 100 year flood levels.

Biology

Under Alternative F, changes in treatment plant discharge and combined sewer overflows would affect biology as described below.

Terrestrial habitats. No regional impacts are expected. Impacts at treatment plant sites are described in Volume II of the EIS series.

Shoreline habitats. CSO pollutants loads to Lake Washington and to Lake Union/Ship Canal marshes would be reduced by a small amount (8 - 15 percent) (Metropolitan Engineers, 1977). The effects are not expected to change from baseline levels.

The intertidal. The main changes on the intertidal would result from reducing combined sewer overflows to saltwater (15 percent at Elliott Bay and 97 percent at Alki relative to Alternative B), instituting secondary treatment, and establishing a major discharge from Duwamish and Renton plants off Alki Point.

Assuming that effluents from all Puget Sound outfalls come onshore occasionally, the major reduction in loads relative to baseline levels due to secondary treatment would be a benefit to the intertidal. It is recognized that effluent has been found only on one occasion at West Point, but the same eddy patterns that develop north and south of West Point and have been implicated in the effect appear at Alki, and onshore water movements appear to occur during part of each tidal cycle at Carkeek Park and Richmond Beach based on the results of the University of Washington physical model. The total effluent load to the intertidal is unknown.

The reduction in overflows to the intertidal is judged to be a moderate benefit, limited in extent along the beaches, but of long duration for solids, BOD, nutrients, metals and toxicants.

Overall, nutrient loads (from CSO's and effluents), which appear to have the most discernable effect on the intertidal, would be reduced. Effects on intertidal algae near West Point would remain at existing conditions but less than Alternative B. Further changes in the diversity and abundance of intertidal plants and animals would probably continue, however, as the pattern of natural succession may have been affected. Effluent from the new outfall at Alki may or may not reach shore, depending on design.

Dechlorination facilities could reduce the occurrence of chlorine residual peaks that may exceed safe levels for marine life in receiving waters. Better disinfection and CSO control could reduce the fecal coliform bacterial levels in shoreline waters such that state standards for shellfish waters might be met and potential health risks to shellfish consumers be reduced.

At the same time, Alternative F includes a Carkeek-West Point interceptor (along the shore of Puget Sound and crossing Shilshole Bay), for which construction impacts are expected to be major, adverse, but limited in extent and temporary. The regional impact is judged to be minor. The substrate would be removed and much turbidity generated, locally destroying benthic communities and reducing light levels.

Puget Sound. As in the intertidal, the loads of BOD, solids, metals and toxicants would be reduced to nearshore and offshore waters. Loads of nutrients would increase due to the new flows through Alki.

Offshore phytoplankton would probably be affected by the higher nutrient loads in the increased flows off Alki, and the distribution may be altered through extension of the outfall. The major new plume would discharge near one of the two areas in the Central Sound where algae blooms develop. The present increase detected in primary productivity extremes in the vicinity of West Point could very well appear similarly near the new Alki outfall, from which effluent discharge would be over 25 percent greater. The resulting effect on the algal productivity of central Puget Sound is considered to be a moderate, negative impact, extensive and of long duration as flows continue, but reversible.

Coliform bacteria levels in waters could decrease, reducing possible health risks from consuming shellfish, as a result of improved chlorination facilities and extension of the Alki outfall. Bacterial and virus inputs to Puget Sound from overflows would also be decreased. Whether state fecal coliform standards would be met cannot be determined at this time. Improved chlorination and dechlorination could also reduce the risk of occasional chlorine toxicity of unknown magnitude to animals near the outfalls.

The apparent influence of the West Point and Carkeek effluent plumes on benthic community composition would be reduced at Carkeek after its abandonment, and probably continued at West Point with flows continuing at about present levels. Similar effects may very well occur at Alki and Richmond Beach, but these areas have not been sampled. Effects of nutrients would be about the same, as these are not removed significantly by secondary treatment. Solids and BOD loads, however, would be substantially reduced so the roles of these parameters in maintaining observed patterns in animal distribution and abundance could also be reduced.

The composition of fish assemblages and incidence of tumorous flatfish near the outfalls may or may not change with secondary treatment of effluents as the attractions for particular species to the outfalls have not been identified. It would be useful to monitor the incidence of tumorous fishes at Alki with the installation of the new outfall and greatly increased discharges at that point.

The Carkeek-West Point interceptor would cross Salmon Bay, which is critical for migratory fish species of the Lake Washington drainage basin and supports many of the marine species found in the Seattle area. The bay is also a resting and feeding area for migratory water birds. Alterations in the water quality due to laying of the pipe could increase migratory fish susceptibility to natural mortality and predation for the period of construction. Other organisms which may be affected include geoduck beds, octopus and bottom fish stocks. The impact is judged to be major but temporary, highly limited and probably reversible. The effects of reducing Carkeek to a wet weather facility are described in the site document which is Volume II of this series.

Commercial and sport fisheries. Salmonid runs up the Ship Canal and through Lake Washington would experience small (31 percent relative to Alternative B) reductions in overflows, BOD and solids loads. Impacts of these and other inputs, such as turbidity, nutrients, metals and toxicants would be essentially as under existing conditions and similar to effects described under Alternative A. Overflows to the Duwamish would also continue at Alternative A and B baseline levels. The effect of removing Renton effluent from the Duwamish is discussed in a subsequent section on secondary impacts.

Herring fisheries and eelgrass beds at Alki would probably benefit from the essential elimination of overflows to the Alki/West Seattle beaches in Alternative F and from the extension of the Alki outfall. Juveniles and larval herring, salmonids and bottom fish feeding inshore in areas occasionally affected by effluents would probably benefit from the decrease in toxicants and metals loadings which otherwise could accumulate in their prey. The beneficial impact could be minor-to-moderate, possibly somewhat limited in the central Sound and long-term as effluent discharges continue.

The construction of the Carkeek-West Point interceptor could disrupt fish migration and freshwater-saltwater transition areas in Shilshole Bay through excavation of the bottom, physical obstacles, noise, turbidity and possible resuspension of toxic elements in the sediment. The result could be increased fish mortality and predation. The adverse impact is considered to be major, but limited in extent and of short duration.

The Duwamish estuary. Combined sewer overflows to the Duwamish would remain as in Alternative B and existing conditions, for which impacts have been described previously. Effects from removing Renton discharge are discussed under secondary impacts.

Freshwater environments. Alternative F provides minor CSO control to freshwaters.

1. Lake Washington. Since CSO reduction would be minor (31 percent less than Alternative B), moderate, limited, negative impacts would continue along the western shore. Minor impacts could occur in offshore waters, as overflows tend to move along shore rather than into deeper waters immediately. Lake shore and shallows biota would continue to be exposed to BOD, solids, sediments, nutrients, metals, toxicants, pesticides, oil and grease and pathogens.

2. Lake Union/Ship Canal. CSO flows and loads would continue essentially at 1975 (and Alternative A levels) for which impacts have been described, and would be about 31 percent lower than Alternative B. The stress on the biota of

these waters would be essentially unchanged from present levels, but less than in Alternative B.

3. Lake Sammamish, Sammamish River, Cedar River, Green River, and other waters. No impacts are expected.

Rare and endangered species. No listed species are recorded from the study area. Sensitive habitats were discussed previously.

Energy and Natural Resources

Energy and chemical consumption are summarized in Table 3-30.

Energy. For Alternative F, a net of 81 million equivalent kwh/year of energy would be consumed in 2005 by the West Point, Richmond Beach, Carkeek Park and Duwamish plants. Included would be 77 million kwh/year of electrical energy purchased. This is equivalent to the amount of electrical energy 3800 households would consume per year, and constitutes approximately 0.38 percent of the projected electrical energy consumption of Seattle in 2005 (Appendix E).

Table 3-30 shows the breakdown of total energy consumption on a plant-by-plant basis. The greatest energy consumption would in the form of electricity. Chemicals account for about 10-20 percent of energy consumption, and sludge trucking for less than 5 percent. In the anaerobic digestion of sludge, there would be a net production of energy because of methane formation.

The impact of the energy consumption would be adverse, moderate-to-high in magnitude, long-term, irreversible and definite.

Chemicals. Annual chlorine consumption would be 2285 tons for all facilities. In addition, West Point and Duwamish would use lime and ferric chloride, with annual consumptions of 3645 and 725 tons, respectively. Sulfur dioxide use for dechlorination would require 665 tons per year.

The impact of chemical usage would be adverse, minor, long-term, irreversible and definite. The supplies of chlorine and sulfur dioxide are highly reliable. Lime and ferric

TABLE 3-30

ENERGY AND CHEMICAL CONSUMPTION FOR ALTERNATIVE F

	PLANT					
	Richmond Beach	Carkeek Park	West Point	Alki	Duwamish	Total
Onsite Energy						
Purchased electricity (kwh x 10^6/yr)	2.20	0.46	52.43	1.36	20.25	76.70
Produced by digestion (kwh x 10^6/yr)	0.42	-	15.43	-	3.79	19.64
Consumed by digestion (kwh x 10^6/yr)	0.17	-	6.17	-	1.52	7.86
Offsite Energy						
Chemicals (kwh x 10^6/yr)	0.12	-	9.19	-	4.82	14.13
Sludge Trucking (kwh x 10^6/yr)	0.10	-	0.92	-	0.87	1.89
TOTAL	2.17	0.46	53.28	1.36	23.67	80.94
CHEMICAL CONSUMPTION:						
Chemicals (tons/yr)						
Cl_2	35	-	1490	-	760	2285
SO_2	10	-	450	-	205	665
CaO	-	-	2295	-	1350	3645
$FeCl_3$	-	-	470	-	255	725

chloride are in moderate supply.

Human Environment

Alternative F has both beneficial and adverse impacts to the human environment.

Land use. Major land use changes would include space for a new Duwamish facility and rights-of-way for the following interceptors: North Creek-Hollywood connection, Redmond connection, Val Vue connection, Carkeek Park connection, and Alki connection to Duwamish. In addition, land would have to be made available for the Montlake and Third Avenue West regulator stations, and the Kenmore pumping station and CSO holding tank. If the Carkeek Park connection, the North Creek-Hollywood connection, and the Kenmore CSO holding tank or pumping station are within 200 feet of the shoreline (of Puget Sound or Lake Washington), permits would have to be obtained from the Shorelines Management Master Program for Seattle and King County. The impact of these land uses would be adverse, major, short-term, definite and reversible.

Expansion at the West Point, Carkeek Park and Richmond Beach facilities would also depend on these SMMP permits (at Richmond Beach, the permit would be obtained from King County). The impact of these installations on land use would be adverse, major, long-term, irreversible (because of the financial constraints related to moving a secondary treatment facility) and definite.

In the Duwamish region, many sites have been considered. The one evaluated in detail for Alternative F is at Harbor Avenue S.W., an undeveloped site in an industrial area. Since the area is on filled, former delta land, it may be in the state-designated Duwamish flood zone, necessitating a county permit before development.

Legal and institutional. Alternative F would fulfill the requirements of PL 92-500 and Washington NPDES regulations that secondary treatment be established. This impact is beneficial, major, long-term, reversible, and definite. Relationship to NPDES and EPA timing requirements for secondary treatment would be as described for Alternative E.

Permits from the Shorelines Management Master Program for Seattle would have to be obtained at any location within the Seattle city limits where construction occurs within 200 feet of shoreline, as explained under land use considerations.

Agency goals. Alternative F, which implements secondary treatment, fulfills certain King County and Goals for Seattle objectives as described under Alternative E.

It is speculative whether alternative satisfies the PSCOG goal of "encouraging conservation efforts and maximizing utilization of utilities and services before increasing supply," when the fully built facility at Alki is abandoned. However, this alternative does fulfill the PSCOG goal of "maintaining the natural beauty and liveability of the region," at Alki, at least, by removing the facility at that site, but not until 1985. The Alki plant is currently in a residential district, and has been the focus of much vocal opposition due to odors.

For the facility placed in the Duwamish region to replace Alki, no surveys were available for the Draft EIS of the Duwamish residents and businessmen to determine their response. Such a survey was recommended to more fully assess impacts of this alternative and is now being conducted by Metro. The potential advantage of greater compatibility of land uses achieved by locating a wastewater treatment plant in an industrial rather than residential area should be compared with any potential disadvantage of losses in employment opportunities and regional tax base.

Employment. It has been estimated that the construction involved in this alternative would require the employment of 450 workers for five years. Operation and management would require 119 employees at the West Point, Carkeek Park, Richmond Beach and Duwamish facilities.

Costs. For Alternative F, the estimated capital cost for constructing new treatment facilities, collection systems, effluent disposal sites, sludge handling and disposal facilities (exluding Renton) would be $286,500,000 (1976 dollars), as summarized in Table 3-13 (Metropolitan Engineers, 1977). This is 0.30 percent of the $95.902 billion estimated by the EPA for implementation of PL 92-500 throughout the country (EPA, 1976). The operation and maintenance costs (excluding Renton) would be $8,820,000 per year, as shown in Table 3-13 (Metropolitan Engineers, 1977).

The estimated Metro average monthly user charge per equivalent connection for the next 20 years would be $6.85 per month if all future facilities to 2005 are grant eligible, as shown in Table 3-14. User charges would be $8.60 per month if future capacity beyond 1985 is not grant eligible and would be $12.75 per month if no future facilities are grant eligible. Since Alternative F complies with the secondary treatment requirement of PL 92-500, which is a condition for grant funding, it appears that the probable user charge would be either $6.85 or $8.60 per month, an amount $1.55 below or $0.20 above the average expected user charge in Alternative B. Impact of cost would be adverse, moderate, long-term, irreversible, and definite.

Social, recreational and cultural. Alternative F would fulfill the goal of 54 to 64 percent of those interviewed (HRPI, 1976) who expressed a preference for secondary treatment as described under Alternative E.

Alki residents would not have a wastewater treatment plant in their area after 1985, which is considered a minor cultural advantage for them; however, the impact of a nearby wastewater treatment plant would be transferred to the Duwamish residents and business community.

When the Carkeek Park connection is installed, there may be a temporary effect on accessibility to recreational swimming. Commercial and sport fishing may improve due to better water quality, as explained in the biological section of this EIS. Recreational shellfishing may be less of a health risk when there is secondary treatment and improved chlorination of wastes before they enter Puget Sound.

Impacts on the parks or recreational facilities close to the West Point, Alki, Carkeek Park facilities are explained in those respective site-specific documents. Since only the Montlake and Third Avenue West regulator stations would be installed for control of combined sewer overflows, there still may be coliform levels exceeding health standards at swimming beaches along Lake Washington. This is considered adverse, major, long-term, reversible, and possible.

Archeological and historical. It has been determined that any archeological sites which may have occurred at West Point, Carkeek Park, and Richmond Beach would have already been destroyed by former construction; therefore, any more construction could not destroy archeological sites (Jerry Jermann, 1976). Archeological sites at the Harbor Avenue location have not been determined. None of the historical sites listed in Appendix F are known to be present at proposed construction sites.

Health and safety. The major negative impact would be associated with fecal coliform violations at Lake Washington public beaches.

Another highly unlikely safety hazard is accidental leakage of chemicals when they are in transport, or handled on site. Although nearly every U.S. water and wastewater treatment facility uses chemicals, there have been very few chemical-related accidents.

The health and safety problems related to sludge transport and disposal would be as probable as for any other trucks in transit.

Under Alternative F, oxygen activated sludge would be installed at West Point. With this method of secondary treatment, oxygen is mixed into the activated sludge basin for the respiratory functions of the microorganisms which digest sewage. If this oxygen comes in contact with hycrocarbons (such as gasoline) in the presence of a spark, there could be an explosion. However, this situation should never arise. Oxygen activated sludge facilities are designed to provide continuous monitoring of hydrocarbon concentration. Far below dangerous hydrocarbon levels, an alarm will sound, and oxygen would be vented to bypass the activated sludge basin. The impact of an explosion could be adverse, major, long-term, reversible, but would be highly unlikely. For the oxygen activated sludge facilities used around the country, there have not been any incidences yet of explosions.

Construction risks to safety would be the same as for other construction of a similar nature; they would be adverse, minor, last only for the duration of construction, may be reversible, and are unlikely.

Aesthetics and nuisance. Introducing secondary treatment at West Point, Duwamish and Richmond Beach would generate some site-specific nuisance impacts for local residents, as discussed in more detail in Volume II for various sites. However, surveys and public workshops have generally indicated that people in the locales of these facilities thought "cleaning up the environment" was more important than such aesthetic issues as hiding the facility (5 to 8 percent) (HRPI, 1976). These aesthetic and nuisance impacts are rated as adverse, minor, long-term, reversible, and definite.

A local benefit would occur by abandoning the Alki facility, which gives off odor, and can be seen from nearby residences and streets. Data on the Duwamish site is not available yet.

Interceptor construction would be a short-term, reversible, local, and probable nuisance, especially for the Duwamish-Alki tunnel. Blasting, often associated with tunneling, could disturb local residents in this highly populated district.

Secondary Impacts

The secondary or indirect impacts of the alternative would result from expanding the Renton treatment plant and population growth. The effects of these changes on water quality, biology, energy, natural resources and the human environment are described below.

Water Quality

Duwamish estuary. Diverting the Renton discharge to Puget Sound would substantially reduce the degradation of water quality in the Duwamish. By the year 2005, this action would protect the Duwamish from Renton discharges planned for other alternatives in the range of 86-99 mgd. The Duwamish summer low flow would no longer be augmented by Renton, but the water quality even then would probably be better without the solids, BOD, nutrients, and ammonia of the Renton effluent. The net beneficial effect of removing the Renton effluent from the Duwamish would be major, because Renton discharges a considerable quantity of effluent which exerts a considerable effect on Duwamish water quality. Impacts would be limited to the Duwamish River and estuary and long-term because the benefits would extend through the planning period.

Groundwater and surface waters. Impacts of population growth (additional urban runoff to surface waters) and some unsewered population (possible effects of septic tank leachate on groundwater) would be as described for Alternative B.

Biology

With removal of Renton discharge to the Duwamish, the river flow would be lower in summer, but the oxygen demand

and high nutrients levels in Renton's effluent would no longer be acting on the biotic communities; therefore, the maximum size of algae blooms could decrease somewhat. Because the Duwamish is an important estuarial zone for migrating fish, an improvement in water quality could decrease fish mortality, although temperature would continue to be a problem in summer. The overall impact is judged to be a moderate-to-major, long-term benefit to the biota of the estuary, although overflows would continue at baseline levels.

Energy and Natural Resources

Energy. For Alternative F, a net of 53 million equivalent kwh/year of energy would be consumed in 2005 at Renton. Included in this would be 56 million kwh/year of electrical energy purchased; and 5 million equivalent kwh/year required to produce the chemicals consumed. There would be no sludge trucking. A net of 7 equivalent kwh/year would be produced by the process of anaerobic digestion. The impact of the energy consumption would be adverse, moderate in magnitude, long-term, irreversible and definite.

Chemicals. Chlorine and sulfur dioxide would be the only chemicals used, at annual rates of 1160 and 350 tons, respectively. The impact of chemical usage would be adverse, moderate, long-term, irreversible and definite. The supplies of chlorine and sulfur dioxide are reliable.

Human Environment

Land use, population and employment. Impacts on regional population growth would be as described under Alternative E and in the separate growth section.

One of the most important secondary impacts of Alternative F concerns commercial fisheries. Improvements in water quality and biologic conditions would result in benefits to the fisheries affected. Although the benefits to Puget Sound from secondary treatment may be difficult to measure and the benefits attributable to improved wet weather management would be intermittent, the improvements would be expected.

Operation and management employment at Renton would include 72 people, plus other Metro related staff. Construction would involve approximately 350 employees for 5 years.

Costs. If Alternative F is implemented, capital costs for construction at Renton would be $191,500,000, as indicated in Table 3-13. Renton operation and maintenance would cost $4,380,000 per year. The effect on user charges is noted in the primary impact section, since user charges are determined on a Metro-wide basis. Impact of cost would be adverse, moderate, long-term, irreversible, and definite.

Social, recreational and cultural. Some minor benefits to swimming and boating would result from limited CSO control to Lake Washington, Lake Union and the Ship Canal.

Mitigation Measures

Several mitigation measures are suggested to aid in the reduction of adverse impacts resulting from the implementation of this alternative.

A preconstruction monitoring/evaluation study should be undertaken at Alki to determine possible effects of Alternative F on the biota in the area. Under Alternative F, the Alki outfall would be expanded to discharge flows from Duwamish and Renton, which would be 25 percent larger than the West Point flow under Alternative F. Little information is available concerning the marine and benthic organisms, water quality, or current patterns in this region.

Pretreatment of industrial wastes could be provided before sewage enters the West Point plants. If current practices continue, influent to these facilities would occasionally contain slugs of cadmium, mercury and arsenic.

Socioeconomic studies are being conducted in the Duwamish area to determine reaction to the Harbor Avenue or optional sites.

Visual nuisance of the wastewater treatment facilities can be mitigated by (1) designing new facilities and additions to existing facilities utilizing natural geographical conditions (e.g., bluffs) and (2) landscaping the facilities.

Odor of the wastewater treatment facilities can be mitigated, in part, by not allowing the system to become anaerobic. Under anaerobic conditions, noxious gases such as methane and sulfur dioxide are emitted. Interim odor control measures for Alki are being evaluated by Metro.

The energy impact can be in part defrayed by utilizing more of the methane gas which is produced by anaerobic digestion. Nearly half of this methane gas is flared off under current practices. However, it should be determined whether methane storage and transport would be cost-effective.

The high coliform levels at public beaches could be reduced by using the CATAD (Computer Augmented Treatment and Disposal) system to plan the discharge of CSO overflows at sites remote from the public beaches as a first preference.

Unavoidable Adverse Impacts

Under Alternative F - Secondary/Southern Strategy, the following adverse impacts would be unavoidable:

- Construction impacts
- Sludge trucking
- Combined sewer overflows
- Land use changes
- Aesthetic nuisance of plant location
- Operating and maintenance (O & M) and capital costs
- Energy consumption

For greater detail regarding unavoidable impacts, the reader is referred to the preceding impact analysis.

ALTERNATIVE G
SECONDARY/WEST POINT PHASEOUT OPTION

The description of Alternative G and its projected impacts to the year 2005 are presented in this section.

Description

Alternative G would provide a new secondary treatment plant in the Interbay area. Several sites were evaluated in the Draft Facility Plan, including the Golf Park (Garbage Dump) and Commodore Way sites. After incorporating public input and site considerations, the Golf Park site was chosen for the Interbay area treatment plant in the Draft Facility Plan. However, since there has been so much public reaction to the optional Commodore Way site, the impacts of locating a plant there are also evaluated in this EIS.

With the Interbay plant, it may be possible to phase out the West Point plant in the future if service area flows are reduced greatly. In the interim, West Point would function as a wet weather primary treatment plant. Dry weather flows from Carkeek Park would be transferred to Interbay. Alki and Richmond Beach would be upgraded to secondary treatment.

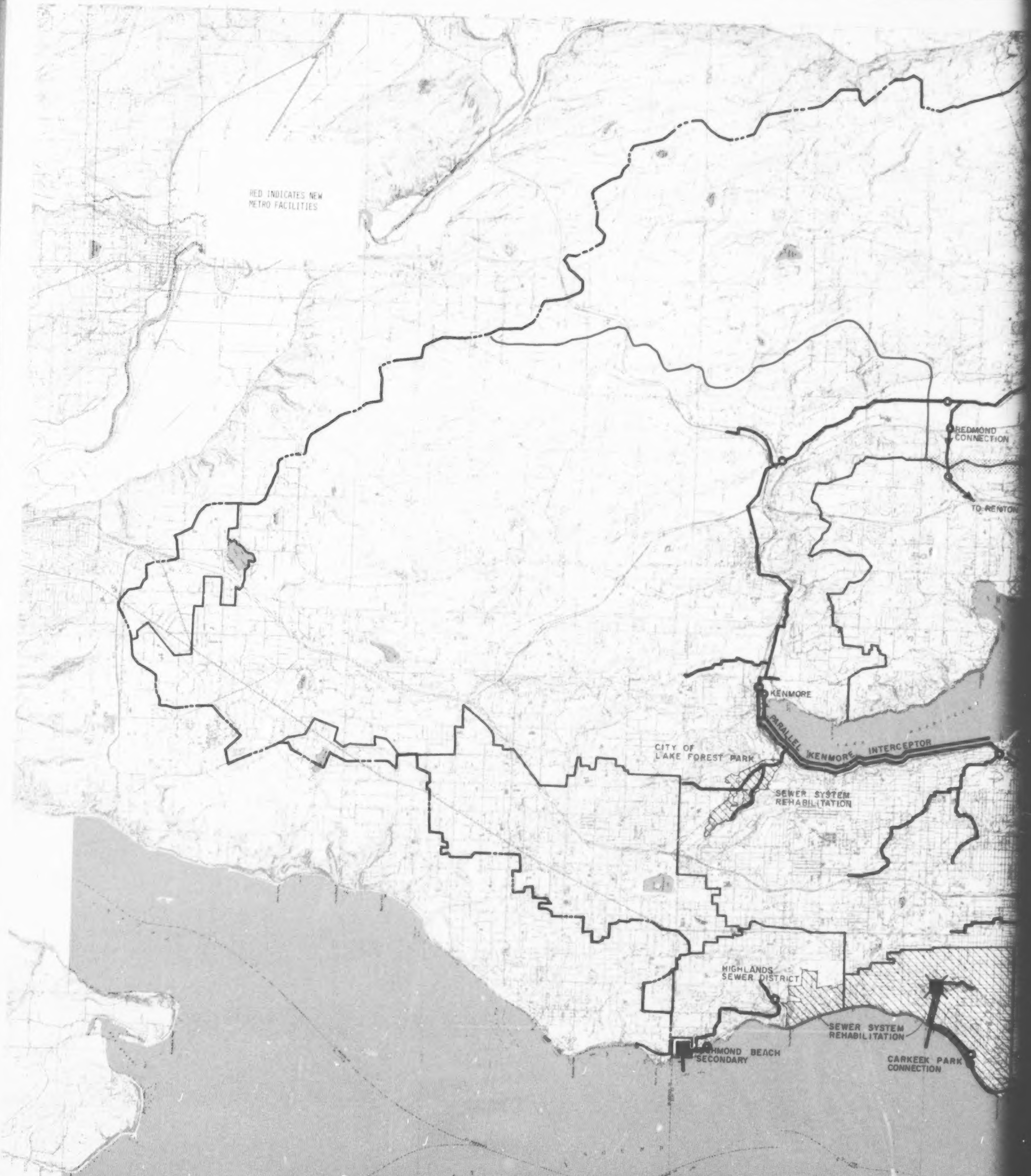
The major wastewater facilities proposed for Alternative G are illustrated in Figure 3-17. Major features of the alternative are summarized in Table 3-31, including treatment plants, combined sewer overflows, and major new transfer facilities. The construction schedule and costs for proposed facilities are shown in Table 3-32.

The alternative is further described below in terms of service area, treatment plants (location, treatment process, effluent disposal site), combined sewer overflow control, and sludge management. The indirect impacts of the facilities proposed under this alternative on the Renton plant are also described.

Service Area

The service areas of Alternative G would be as shown in Figure 3-1. Major changes included are described below.

The Interbay service area would remain the same as for West Point in Alternatives B and E. North Lake Sammamish would be transferred to Renton via the Redmond connection.


RED INDICATES NEW METRO FACILITIES
REDMOND CONNECTION
TO RENTON
KENMORE
PARALLEL KENMORE INTERCEPTOR
CITY OF LAKE FOREST PARK
SEWER SYSTEM REHABILITATION
HIGHLANDS SEWER DISTRICT
HMOND BEACH SECONDARY
SEWER SYSTEM REHABILITATION
CARKEEK PARK CONNECTION

A

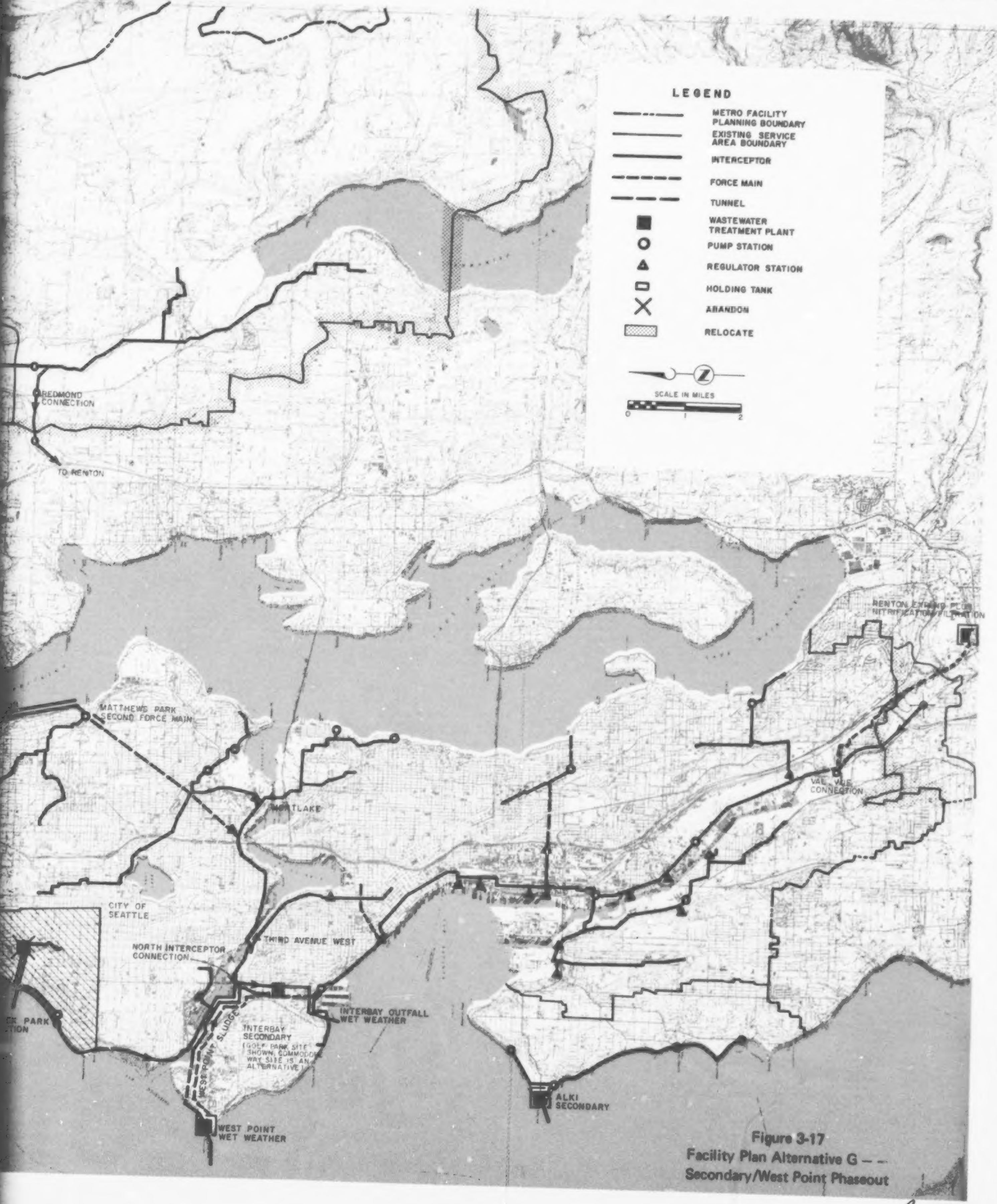

LEGEND
METRO FACILITY PLANNING BOUNDARY
EXISTING SERVICE AREA BOUNDARY
INTERCEPTOR
FORCE MAIN
TUNNEL
WASTEWATER TREATMENT PLANT
PUMP STATION
REGULATOR STATION
HOLDING TANK
ABANDON
RELOCATE
Z
SCALE IN MILES
0
1
2
REDMOND CONNECTION
TO RENTON
RENTON EXPAND PLUS NITRIFICATION/FILTRATION
MATTHEWS PARK SECOND FORCE MAIN
MONTLAKE
VAL VUE CONNECTION
CITY OF SEATTLE
NORTH INTERCEPTOR CONNECTION
THIRD AVENUE WEST
EK PARK
TION
WEST POINT SLUDGE
INTERBAY SECONDARY
(GOLF PARK SITE SHOWN, COMMODORE WAY SITE IS AN ALTERNATIVE)
INTERBAY OUTFALL WET WEATHER
WEST POINT WET WEATHER
ALKI SECONDARY

Figure 3-17
Facility Plan Alternative G — — Secondary/West Point Phaseout

β

TABLE 3-31

ALTERNATIVE G - SECONDARY/WEST POINT PHASEOUT OPTION

SUMMARY

TREATMENT PLANTS

	WEST POINT		ALKI	CARKEEK PARK		RICHMOND BEACH	INTERBAY	RENTON*
				Phase I	Phase II			
Process	Primary		Secondary	Primary	Abandoned	Secondary	Secondary	Secondary + Nitrification and Filtration
Improvement Complete	1979	1985	1983	1985	1995**	1981	1985	1995
Flow (mgd) 2005 (unless phased) average/peak	99/350	0/350	10/30	0/20	0/0	2.5/8	145.5/200	86/223
Disposal	Puget Sound	Puget Sound	Puget Sound	Puget Sound (Dry Weather to Interbay)	To Interbay	Puget Sound	West Point Outfall (Dry Weather); New Elliott Bay Outfall (Wet Weather)	Duwamish

COMBINED SEWER OVERFLOW (2005)

	FLOW (Million Gallons/Yr)	SOLIDS (Tons/Yr)	BOD (Tons/Yr)
Lake Washington	23.0	20.9	5.72
Lake Sammamish	0	0	0
Portage Bay	232	247	60.8
Lake Union	58.1	52.7	14.4
Ship Canal	261	236	64.9
Elliott Bay	358	325	89
Alki Beach	5.46	4.95	1.36
Duwamish/Green River	251	227	62
TOTAL	1,188.6	1,113.6	298.2

TREATMENT PLANT DISCHARGE

	FLOW (Million Gallons/Yr)	SOLIDS (Tons/Yr)	BOD (Tons/Yr)
West Point	57,700	3,890	3,710
Alki Beach	3,650	228	228
Carkeek Park	0	0	0
Richmond Beach	912	57.1	57.1
Renton	31,350	663	1,308
TOTAL	93,612	4,838	5,303

MAJOR NEW TRANSFER FACILITIES

Location	Year Completed
Carkeek-to-Interbay Connection	1985
West Point-to-Interbay Connection	1985
Second Kenmore Interceptor	1983
Val Vue Transfer (from Renton)	1980
Redmond Connection (to Renton) - Main Project	1988
Redmond Connection (to Renton) - Additional Capacity	1995

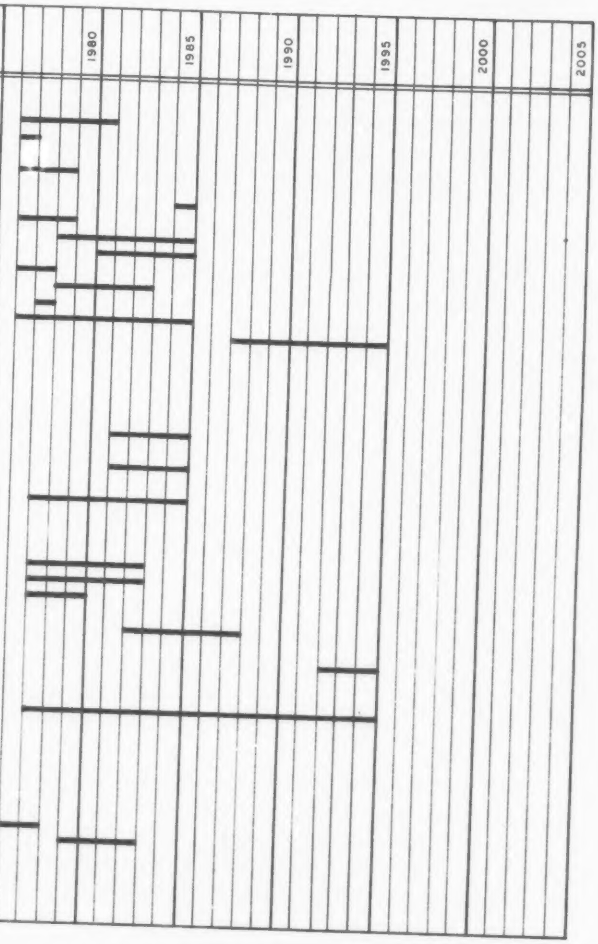
*Not included in proposed facilities plan for Puget Sound plants

**Dependent upon City of Seattle sewer separation program

Table 3-32

Alternative G -- Project Costs and Construction Staging

Facility Component	Project Cost $ Million ENR-CCI - 2600
Treatment Plants	
Richmond Beach Secondary	6.0
Carkeek Park - Interim Improvements	0.1
Carkeek Park - Abandon	
West Point - Interim Improvements	4.8
West Point - Conversion to Wet Weather Plant	0.2
Interbay - Early Construction	4.5
Interbay - Main Construction	230.6
Interbay - Outfall to Elliott Bay	15.4
Alki - Interim Improvements	0.3
*Alki - Secondary Treatment	26.2
*Renton - Interim Improvements	0.4
*Renton - Enlargement II and Upgrading	65.5
Renton - Enlargement III	46.0
Subtotal - Treatment Plants	400.0
Collection System	
Accommodate Carkeek Abandonment	7.4
North Interceptor Reconnections (Accommodate Interbay Plant)	14.0
Rehabilitation of Existing Collection System	18.0
*Increased Transfer Capacity Within Interbay Existing Sewered Area	
Second Kenmore Interceptor	22.2
Kenmore P.S. (Permanent)	8.5
Val Vue Transfer (from Renton)	5.5
Redmond Connection (to Renton)-Main Project	14.0
Redmond Connection (to Renton)-Additional Capacity	1.0
Increased Transfer Capacity and Rehabilitation within Renton Existing Sewered Area	27.2
Subtotal - Collection Except CSO Extensions	117.8
Combined Sewer Overflow Control	
Montlake Regulator Station	0.8
Third Avenue West Regulator Station	0.5
Subtotal, Hold and Transport CSO	1.3
Total Capital Cost	519.1



*Renton facilities are not part of the proposed facilities plan.

Val Vue would be transferred to Interbay. To serve increased North Lake Washington flows would require construction of the Kenmore parallel interceptor. (Although transfer options other than the Kenmore parallel are possible, it is included in the Draft Facility Plan and EIS as the proposed action.)

The new transfer interceptors that would be needed to facilitate the new service area modifications would be the North interceptor reconnection to Interbay (1985), the Carkeek to Interbay connection (1985), West Point to Interbay connection (1985), Val Vue transfer from Renton to Interbay (1980), Redmond connections to Renton (1988, 1995) and the Kenmore parallel (1983). Construction schedule for these collection systems modifications would be as in Table 3-32.

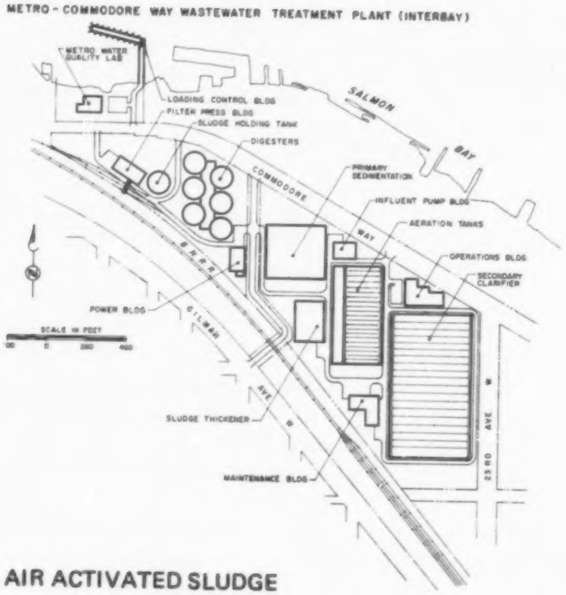
Treatment Plants

The wastewater treatment facilities under Alternative G would be as shown in Table 3-31.

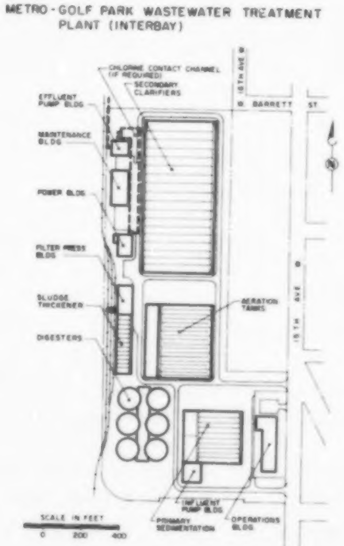
The proposed facility in the Interbay area would be at the Golf Park site (also known as the Garbage Dump site), as shown in Figure 3-18. Air activated sludge would be provided by 1985, requiring 32.6 acres to treat 145 mgd average weather and 200 mgd peak flows forecast for 2005. Treated wastewater would be discharged through the existing West Point outfall during dry weather. The wet weather flows from Interbay would be discharged through a new Interbay outfall to Elliott Bay. The Elliott Bay outfall would be 1200 feet long, discharging at a 50 foot depth west of Terminal 91. According to the facility planning engineers, diffusers on the outfall and its depth would produce a 100:1 dilution of wastewater. Independent preliminary calculations indicate the projected dilution may be optimistic. (The optional Interbay site would be at Commodore Way as shown by the plant layout in Figure 3-18. Although not part of the Facility Plan proposal under Alternative G, this option is considered in the Draft EIS because of the public interest that has surrounded it. Secondary treatment by air activated sludge would be provided. In dry weather, effluent would be discharged to Puget Sound via the existing West Point outfall; in wet weather, it would be discharged through the new Interbay outfall to Elliott Bay.)

(As an option, secondary effluent from the Interbay area plant could be used for lockage flushing water in the Ship Canal during the summer, but this is not part of the proposed alternative.)

West Point would function as a primary plant only during


METRO - COMMODORE WAY WASTEWATER TREATMENT PLANT (INTERBAY)
METRO WATER QUALITY LAB
LOADING CONTROL BLDG
FILTER PRESS BLDG
SLUDGE HOLDING TANK
DIGESTERS
SALMON
BAY
COMMODORE
WAY
PRIMARY SEDIMENTATION
INFLUENT PUMP BLDG
AERATION TANKS
OPERATIONS BLDG
SECONDARY CLARIFIER
BNRR
GILMAN
AVE
W
POWER BLDG
SCALE IN FEET
00
0
200
400
SLUDGE THICKENER
MAINTENANCE BLDG
W
AVE
23RD

SECONDARY – – AIR ACTIVATED SLUDGE


METRO - GOLF PARK WASTEWATER TREATMENT PLANT (INTERBAY)
CHLORINE CONTACT CHANNEL (IF REQUIRED)
SECONDARY CLARIFIERS
15TH AVE W
W BARRETT ST
EFFLUENT PUMP BLDG
MAINTENANCE BLDG
POWER BLDG
FILTER PRESS BLDG
SLUDGE THICKENER
DIGESTERS
AERATION TANKS
W
15TH AVE
INFLUENT PUMP BLDG
PRIMARY SEDIMENTATION
OPERATIONS BLDG
SCALE IN FEET
0
200
400

SECONDARY – – AIR ACTIVATED SLUDGE

Figure 3-18
Interbay Layouts – –
Comprehensive Plan
Service Area

wet weather, beginning in 1985. Effluent would be discharged through the existing outfall. The plant layout would be as in Alternative B, since no structural modifications would be made in the conversion to a wet weather plant. (Chlorine contact and dechlorination facilities would be options, not included in the proposed alternative.)

Secondary treatment by air activated sludge would be provided at Richmond Beach by 1981 and at Alki by 1983. The capacities for each plant and layouts would be as shown under Alternative E (Figure 3-14). Discharge of 10 mgd average; 30 mgd peak flow at Alki would be through the existing outfall. Similarly, at Richmond Beach, the 2.5 mgd average, 8.0 mgd peak flow would be discharged to Puget Sound through the existing outfall. Present plant boundaries would be sufficient for secondary treatment at Richmond Beach, but not at Alki, where expansion into the ballfield area would be necessary.

Effluents from West Point, Alki, Richmond Beach, and Interbay would be chlorinated and dechlorinated prior to discharge.

At Carkeek Park, the existing plant would be converted to wet weather flow only, with primary treatment beginning in 1985. Dry weather flow would be transferred to the Interbay plant for secondary treatment and discharge to Puget Sound through the West Point outfall. It could be phased out and abandoned in 1995, depending on the City of Seattle sewer separation program.

Combined Sewer Overflow Control

In Alternative G, combined sewer overflows would be increased slightly relative to Alternative B, since the flows from the North Lake Washington sewerage service subarea, expected to increase with growth there, would go to Interbay. Approximately 3 percent increase in flows to Lake Washington, Portage Bay, Lake Union and the Ship Canal would result.

The current program for maximizing existing in-line storage capacity for control of combined sewer overflows would be continued with construction of regulator stations at Montlake and Third Avenue West.

Sludge Management

The sludge management system for Alternative G would use anaerobic sludge digestion at Interbay, Richmond Beach and Alki. Additional capacity would be required at Richmond Beach and Alki to handle the larger amounts of solids from secondary treatment. At West Point, digesters would be used for sludge storage during storms; afterwards, sludge would be pumped to Interbay for treatment. Renton sludge would be processed at Renton. Richmond Beach digested sludge would be trucked to West Point for dewatering. Dewatered sludge from Interbay and Alki would be trucked to Cedar Hills landfill and Pack Forest.

Renton

Although the Renton service area and treatment plant are not included in the proposed facilities for Alternative G, the alternative would have indirect impacts on the Renton plant. Based on an increased service area transferred from Interbay to Renton and additional growth in the present Renton service area, the plant would be expanded in two stages (1985 and 1995) to 86 mgd dry weather, 223 mgd wet weather capacity. Upgrading beyond secondary to nitrification and filtration would be provided since the plant would continue to discharge to the Duwamish River. Sludge would be digested anaerobically at Renton, dewatered, and trucked to the Cedar Hills landfill and Pack Forest.

Primary Impacts

The direct impacts from this alternative for the Puget Sound plants are described below in terms of effects on geology, soils and topography; air quality and odors; water quality; biology; energy and natural resources and the human environment. Indirect impacts from this alternative and the effects of Renton discharge are summarized under a later section on secondary impacts.

Geology, Soils and Topography

Site-specific impacts of treatment plant construction and upgrading on slopes, stability, erosion, and deposition are discussed in Volume II of the EIS series, but negligible on the regional level.

Alternatives G also includes the construction of the Kenmore parallel interceptor which may run along the northwest shore of Lake Washington. Impacts such as accelerated erosion and deposition potential, alteration of benthic sediments and seismic risk would be as described under Alternative B.

Impacts would be monitored at sludge disposal sites at Cedar Hills landfill and Pack Forest. With the larger volumes of sludge from secondary treatment and higher wastewater flows, the projected 30 year useful life of the landfill could be shortened by one year if all Metro sludge were disposed of at Cedar Hills.

Construction waste disposal may cause limited but long-term effects on the site chosen. The impact is set by judgment as no sites have been identified and the magnitude of the impact is a function of site. It is expected to be minor, however.

Air Quality and Odors

Trucking sludge from Richmond Beach to Interbay and from Interbay, Alki, and Renton to the Cedar Hills landfill would emit approximately 440 grams of hydrocarbons, 2740 grams of carbon monoxide and 1995 grams of nitrogen oxides per day. Personnel traffic would generate approximately 6080 grams of hydrocarbons, 77340 grams of carbon monoxide, and 10020 grams of nitrogen oxides per day. The combined emissions would amount to less than 0.01 percent of Seattle's total daily emissions of hydrocarbons, carbon monoxide, and nitrogen oxides. Implementation of Alternative G would have a negligible, long-term, adverse, and reversible impact on air quality in the Seattle area. For sludge trucking to Pack Forest, air pollutant emissions would be higher due to the longer travel distances, but the overall impact on regional air quality would be negligible.

Upgrading Alki and Richmond Beach plants to secondary treatment and constructing a new secondary treatment plant in Interbay will increase the potential for odors escaping in these areas. Because secondary treatment plants are larger and more complex than primary plants, expose more water surface area to the air and subject the water to more perturbation, there is a greater likelihood for odors being released into the surrounding neighborhood from secondary treatment plants. Various practical measures can be employed, however, to control treatment plant odors and are discusssed in the section on mitigation measures. At Alki, odor control measures are being evaluated now by Metro. Site-specific EIS documents contain more detail on odors.

Limiting West Point to a wet weather plant only would reduce the possibility of odors there during the dry season. The samll increase in CSO's at Lake Washington, Lake Union, and the Ship Canal will increase slightly the occurrence of CSO-derived odors in these areas. CSO's and their associated odors will decrease in Portage Bay. The potential odor problems associated with this alternative could be said to have a minor, long-term, reversible, adverse impact on the environmental quality of the Seattle area.

Water Quality

Upgrading the Alki and Richmond Beach plants to secondary treatment, providing a new secondary treatment plant at the Golf Park site in Interbay and restricting the West Point and Carkeek Park plants to treating storm flows only would have mixed impacts on water quality.

Lake Washington. Under Alternative G, the yearly volume of CSO's to Lake Washington would be about 3 percent greater than under Alternative B. The adverse effects on lake water quality from these increases would be minor, because the increases are relatively small, but long-term, because the discharges would continue through the planning period. Except for the accumulation of nutrients, heavy metals, pesticides, and PCB's added to the lake by CSO's, the water quality impacts are reversible.

Installation of the Kenmore interceptor along the shoreline of Lake Washington would produce impacts on water quality from sediment disturbance as described under Alternative B.

Lake Union/Ship Canal. In Alternative G, the yearly volume of CSO's to the Lake Union/Ship Canal would be 3 percent greater than under Alternative B. Therefore, impacts would be essentially the same as described for Alternative B.

Secondary effluent from the proposed Interbay (Golf Park) treatment plant might be discharged into the Ship Canal for lockage in the summer months. Because the Ship Canal is already subject to occasional to frequent occurrences of violations of state standards for coliforms and dissolved oxygen and to algal blooms (especially in summer) the discharge of up to 145 mgd of secondary effluent would cause major, adverse impacts on water quality. The secondary effluent would be higher in nutrients, temperature and BOD, and lower in DO than the receiving waters, and would be disinfected. These factors could directly or indirectly aggravate the existing water quality stress on migrating fish. The effect is considered to be long-term (because discharges would continue through the planning period) and reversible (unless fish populations are seriously affected by summer discharges over a number of years).

If the effluent from the Interbay plant is discharged to Puget Sound through the West Point outfall, the effect on the Ship Canal of a 3 percent increase in CSO's would be minor (because the increase is not great) and long-term (because the increased discharges would continue through the planning period). Except for the increased accumulation of PCB's, pesticides, and heavy metals, impacts would be reversible.

Other freshwaters. Alternative G would not directly affect other freshwaters such as Lake Sammamish, Green River, Cedar River or Sammamish River.

Duwamish estuary. Combined sewer overflows would be the same as under Alternative B, for which impacts have been described. In 2005, CSO flows, solids and BOD would represent 0.8, 34, and 5 percent respectively of the Renton treatment plant discharge on an annual basis.

Puget Sound. Alternative G would discharge treated effluent flows and pollutant loads to Puget Sound through West Point, Alki and Richmond Beach outfalls in amounts essentially identical to Alternative E. Thus, even though Alternative G would contain an Interbay rather than West Point plant for dry weather treatment, the fact that effluent would be discharged through the West Point outfall in dry weather would produce regional water quality impacts on Puget Sound that would be essentially identical to those described under Alternative E.

Since combined sewer overflows to Elliott Bay and Alki Beach would remain as in Alternative B, impacts of CSO's would be as described for Alternative B.

The discharge of up to 200 mgd secondary effluent from the Interbay plant to Elliott Bay through a new outfall could affect water quality in the vicinity of the outfall. However, since information on discharge frequency, volume or quality is not yet available, water quality impacts cannot be evaluated fully. Preliminary calculations indicate diluted wastewater could surface, producing a visible boil. Localized increases in dissolved oxygen could occur.

Groundwater. Treatment plant discharges to Puget Sound would not affect groundwater. Impacts of sludge disposal on groundwater near the Cedar Hills and Pack Forest sites would be monitored.

Flood hazard. No flood hazards are expected for Alternative G, as all sites are above 100 year flood levels.

Biology

Several elements of Alternative G including treatment plant discharge and combined sewer overflows could affect the biology of the study area.

Terrestrial habitats. The possibility of eventual phase-out of the West Point treatment facility would allow the present site to return to more natural conditions suitable for wildlife and vegetation. This minor benefit is discussed in the West Point site analysis, Volume II of this EIS series. Other direct impacts on regional terrestrial habitats are judged to be negligible.

Shoreline habitats. Effects of combined sewer overflows to marshes in Lake Washington and the Ship Canal would be essentially the same as for Alternative B. Similarly, impacts from the Kenmore parallel interceptor construction on Lake Washington salmon spawning areas would be as described in Alternative B.

The intertidal. Combined sewer overflows at Alki Beach and to Elliott Bay would affect intertidal biota through nutrient, toxicant and microbiological inputs to the same degreee as described under Alternative B. Impacts for treatment plant discharges would include diluted effluent adding nutrients and toxicants to beaches that contain algae, shellfish and eelgrass beds, as described under Alternative E.

Puget Sound. Impacts on phytoplankton, algal production, abundance and distribution of benthic organisms, and fish from treated wastewater discharge would be as described under Alternative E.

Combined sewer overflow discharges and impacts would be as discussed for Alternative B, except for the addition of wet weather treated wastewater discharge from Interbay to Elliott

Bay. Biological impacts are uncertain due to limited data, but fish in the vicinity could be subjected to additional stress from changes in water quality.

Commercial and sport fisheries. Since secondary effluent could be discharged to Ship Canal for lockage in summer from the Interbay plant, the added nutrients and BOD would probably have major adverse effects on already stressed migratory (and other) fish species. Discharge to Shilshole Bay would not be a great improvement, as that water is not well mixed. Effects of combined sewer overflows would be as described for Alternative B. The effects of the expansion of the Renton facility are discussed in a subsequent section on secondary impacts.

Secondary effluent discharge to Puget Sound, which will affect nearshore commercial and sport fish at some stage in their lives, would be beneficial relative to primary treatment in having better disinfection and lower concentrations of metals, toxicants and pathogens. This effect is judged to be minor-to-moderate, somewhat limited in extent in the central Sound, and long-term.

The Duwamish estuary. Since overflows to the Duwamish would continue at baseline levels, biological impacts would be as described under Alternative B.

Freshwater environments. The impacts on these waters as in previous alternatives are primarily a function of overflow control.

1. Lake Washington. Organisms would continue to be affected by baseline levels of oil, grease, nutrients, pathogens, solids, metals and toxicants along the western lake shore, as described under Alternative B.

The construction activities of the Kenmore parallel interceptor could create turbidity, destroy habitat and frighten away fish, birds, mammals and other vertebrates. Salmon spawning areas could be silted over. The impact is considered to be major but temporary and limited in effect, as described under Alternative B.

2. Lake Union/Ship Canal. CSO's would not be reduced, and up to 145 mgd of secondary effluent could be discharged to this water in summer for locakage. The overall effect would

adverse, major, extensive and long-term, as the effluent would probably contain toxicants, low levels of DO and substantial nutrient loads. The existing stress on biota would probably be significantly aggravated and increased fish mortality could result.

3. Sammamish River, Cedar River, Green River, Lake Sammamish, and other waters. No direct impacts are expected to these waters under Alternative G.

Rare and endangered species. No impacts are expected as no listed species are recorded from the study area. Sensitive habitats have been discussed previously.

Energy and Natural Resources

Energy. For Alternative G, a net of 85 million equivalent kwh/year of energy would be consumed in 2005 by the Interbay, West Point, Alki, Carkeek Park and Richmond Beach plants. Included would be 84 million kwh/year of electrical energy purchased. This is equivalent to the amount of electrical energy 4200 households would consume per year, and constitutes approximately 0.42 percent of the projected electrical energy consumption of Seattle in 2005 (Appendix E).

Table 3-33 shows the breakdown of total energy consumption on a plant-by-plant basis. The greatest energy consumption would be in the form of electricity. Chemicals account for about 5-25 percent of energy consumption, and sludge trucking for about 5-25 percent. In the anaerobic digestion of sludge, there is a net production of energy because of methane formation.

The impact of the energy consumption would be adverse, moderate-to-high in magnitude, long-term, irreversible, and definite.

Chemicals. Regional chemical consumption at treatment plants would include 2210 tons of chlorine, 710 tons of sulfur dioxide, 2975 tons of lime (CaO), 560 tons of ferric chloride ($FeCl_3$), 35 tons of alum, and 6 tons of polymer per year. Table 3-33 shows a breakdown by plant of chemical requirements.

The impact of chemical usage would be adverse, minor, long-term, irreversible and definite. The supplies of

TABLE 3-33

ENERGY AND CHEMICAL CONSUMPTION FOR ALTERNATIVE G

	PLANT					
	Richmond Beach	Carkeek Park	West Point	Alki	Interbay	Total
Onsite Energy						
Purchased electricity (kwh x 10^6/yr)	2.20	0.57	0.37	6.07	74.84	84.05
Produced by digestion (kwh x 10^6/yr)	0.42	-	0.32	1.28	20.00	22.02
Consumed by digestion (kwh x 10^6/yr)	0.17	-	0.13	0.51	8.00	8.81
Offsite Energy						
Chemicals (kwh x 10^6/yr)	0.12	-	0.14	0.59	12.04	12.89
Sludge Trucking (kwh x 10^6/yr)	0.10	-	0.18	0.03	1.19	1.5
TOTAL	2.17	0.57	0.50	5.92	76.07	85.23
CHEMICAL CONSUMPTION:						
Chemicals (tons/yr)						
Cl_2	35	-	30	145	2000	2210
SO_2	10	-	10	45	645	710
CaO	-	-	-	-	2975	2975
$FeCl_3$	-	-	-	-	560	560
Alum	-	-	35	-	-	35
Polymer	-	-	1.0	5	-	6

chlorine, sulfur dioxide, alum, and polymer are highly reliable. Lime and ferric chloride are in moderate supply.

Human Environment

Several impacts on the human environment would result from constructing and operating the Interbay plant.

Land use. Major land uses changes would include space for a new Interbay facility and rights-of-way for the following interceptors: West Point sludge connection, North interceptor connection, Interbay wet weather outfall, Redmond connection, Val Vue connection, and Carkeek Park connection. In addition, land would have to be made available for the Montlake and Third Avenue West regulator stations, and the Kenmore pumping station. Carkeek Park connection, the Kenmore interceptor, the North interceptor connection, and the Interbay wet weather outfall would require permits from the Shorelines Management Master Program for Seattle and King County. Except at the Interbay site, the land uses impacts would be adverse, major, and short-term because the impact only occurs during construction. Effects would be reversible and definite.

Expansion at Alki and Richmond Beach facilities would also depend on these SMMP permits (at Richmond Beach, the permit would be obtained from King County). The impact of these installations on land use would be adverse, major, long-term, irreversible and would definitely occur if Alternative G is implemented in its present form.

In the Interbay area, use of the Golf Park site would eliminate recreational use of this land. (If the optional Commodore Way site were used, a distinct business district predominately related to the sea-food industry would be displaced.)

Legal and institutional. Alternative G would fulfill the requirements of PL 92-500 and Washington NPDES regulations that secondary treatment be established. Impacts would be as described under Alternative E. Permits from the Shorelines Management Master Program for Seattle would have to be obtained at any location within the Seattle city limits where construction occurs within 200 feet of shoreline as explained under land use considerations.

Agency goals. Alternative G, which implements secondary treatment, fulfills the King County comprehensive plans of "taking all possible steps to abate pollution" and "installing utility lines in advance of the time of development." Alternative G fulfills in part the objectives mentioned in Goals of Seattle to "undertake all means reasonable and feasible to ensure water purity to meet health standards and protect the environment. . . to meet the goals of PL 92-500, . . . and to ensure clean water to protect wildlife, vegetation, and recreation areas."

This alternative does not satisfy the goal of PSCOG of "encouraging conservation efforts and maximizing utilization of utilities and services before increasing supply," when the fully built facility at West Point is not used to full potential. However, this alternative does make efforts to fulfill the PSCOG goal of "maintaining the natural beauty and liveability of the region," at West Point and Carkeek Park at least, by not expanding the facilities at these sites. However, it does not fulfill the PSCOG goals of making "existing public utilities, facilties and services be used to their fullest prior to expansion," since the Interbay plant would duplicate some of the same functions existing at West Point, nor does it "consider employment distribution," if the Commodore Way site is chosen (such an action would displace 700 to 800 jobs). Further, if the Commodore Way site is chosen, by displacing as many as 60 businesses, it would thwart the following objectives stated in Goals for Seattle: "Encourage industries that more fully utilize Seattle's resources . . . Help small local firms expand . . . promote individualism inherent in entrepreneurship . . . Ensure adequate consideration of the particular economic interests of Seattle citizens in relation to their local region." This is considered adverse, major, long-term, reversible and definite.

Employment. It has been estimated that the construction involved in this alternative would require the employment of about 650 workers for 5 years. Operation and management would require 148 employees at the West Point, Carkeek Park, Alki, Richmond Beach, and Interbay facilities. However, if the Commodore Way site is used, it would displace 700 to 800 jobs.

Costs. The estimated capital cost for constructing new treatment facilities, collection systems, effluent disposal sites, sludge handling and disposal facilities (excluding Renton) would be $361,800,000 (1976 dollars), as summarized in Table 3-13 (Metropolitan Engineers, 1977). This is 0.30 percent of the $95.905 billion estimated by the EPA for implementation of PL 92-500 throughout the country (EPA, 1976). The operation and maintenance costs (excluding

Renton) would be $9,300,000 per year, as shown in Table 3-13 (Metropolitan Engineers, 1977).

The estimated average Metro monthly user charge per equivalent connection for the next 20 years would be $7.45 as shown in Table 3-14. User charges would be $8.75 per month if future capacity beyond 1985 is not grant eligible and would be $15.20 per month if no future facilities are grant eligible. Since Alternative G complies with the secondary treatment requirement of PL 92-500, which is a condition for grant funding, it appears that the probable user charge would be either $7.45 or $8.75 per month, an amount $0.95 below or $0.35 above the average expected user charge in Alternative B. Impact of cost would be adverse, moderate, long-term, irreversible, and definite.

Social, recreational and cultural. As surveyed by HRPI 54 to 64 percent of the people interviewed in districts adjacent to the wastewater facilities (HRPI, 1976) expressed a preference for secondary treatment as required by PL 92-500. Alternative G would fulfill that requirement, which is considered beneficial, important, long-term, irreversible, and definite.

With the Golf Park site used for the Interbay plant, there would be a loss of golf course, which is hard to replace in a metropolitan area. If the optional Commodore Way site were chosen it would disrupt the seafood processing community. This will be discussed in more detail in the West Point document.

Further, local residents would consider it a social hardship to have both the West Point and Interbay sewage treatment plants in their neighborhood. These impacts are considered adverse, major, long-term, irreversible, and definite.

Since only the Montlake and Third Avenue west regulator stations and Kenmore parallel would be installed for control of combined sewer overflows, there still may be coliform levels exceeding health standards at swimming beaches along Lake Washington. This is considered adverse, major, long-term, reversible, and possible.

Archeological and historical. It has been determined that any archeological sites which may have occurred at Alki and Richmond Beach would have already been destroyed by former construction, and that, therefore, any more construction could not destroy archeological sites (Jerrry Jermann, 1976). Archeological sites in the Interbay region have not been determined. Of the historical sites listed in Appendix F, none are known to be present at proposed construction sites.

Health and safety. A negative impact would be associated with fecal coliform violations at Lake Washington public beaches.

Another highly unlikely safety hazard is accidental leakage of chemicals when they are in transport, or handled on site. Although nearly every U.S. water and wastewater treatment facility uses chemicals, there have been very few chemical-related accidents.

The health and safety problems related to sludge transport and disposal would be as improbable as for any other trucks in transit.

Construction risks to safety would be the same as for other construction of a similar nature; they would be adverse, minor, last only for the duration of construction, may be reversible, and are unlikely.

Aesthetics and nuisance. Introducing secondary treatment at Alki and Richmond Beach would generate some site-specific nuisance impacts for local residents, as discussed in more detail in Volume II for various sites. However, surveys and public workshops in the locale of the facilities showed that cleaning up the environment was considered a higher priority by more people (60 percent) than such aesthetic issues as hiding the facility (6 percent) (HRPI, 1976). These aesthetic/nuisance impacts are rated as adverse, minor, long-term, reversible, and definite.

Interceptor construction would be a short-term, reversible, local, and probable nuisance. Blasting often associated with tunneling could disturb local residents in this highly populated district. Installation of an Interbay facility at the Golf Park site would be a nuisance. In excavation of the garbage which was accumulated for 20 years, it is feared that odorous sulfur compounds and methane gas would be released, and that when in operation, the facility would still release odors. Since the plant would be in a valley which local residents would look down upon, adverse visual effects may affect some residents. A facility at Commodore Way would likewise exert similar nuisances after installation. More detail is presented in the West Point EIS (Volume II).

Tradeoffs in nuisance factors are apparent in Alternative

G (primary treatment at the West Point plant and a new secondary plant in Interbay) and Alternative E (secondary treatment upgrading at West Point, but no Interbay plant).

Secondary Impacts

The secondary or indirect impacts of the alternative would result from expanding the Renton treatment plant, and population growth. The effects of these changes on water quality, biology, energy, natural resources and the human environment are described below.

Water Quality

Duwamish estuary. Impacts on the Duwamish estuary from expanding the Renton plant and discharging 86 mgd average of secondary, nitrified and filtered effluent would be as described under Alternative C.

Surface and groundwater. Impacts of population growth would be as described under Alternative B.

Biology

Impacts from the Renton plant discharge on Duwamish River biology would be as described under Alternative C.

Energy and Natural Resources

Energy. For Alternative G, a net of 56 million equivalent kwh/year of energy would be consumed in 2005 at Renton. Included in this would be 49 million kwh/year of electrical energy purchased, 1 million kwh/year for sludge trucking, and 11 million equivalent kwh/year required to produce the chemicals consumed. A net of 5 equivalent kwh/year would be produced by the process of anaerobic digestion. The impact of the energy consumption would be adverse, moderate in magnitude, long term, irreversible, and definite.

Chemicals. Chlorine, sulfur dioxide, lime, and alum would be used with annual consumption rates of 1020, 305, 7955, and 1145 tons respectively. The impact of chemical usage would be adverse, moderate, long-term, irreversible, and definite. The supplies of chlorine, sulfur dioxide and alum are reliable. Lime is in moderate supply.

Human Environment

Land use, population and employment. Impacts on regional population would be as described under Alternative E.

Operation and maintenance employment at Renton, a secondarily impacted facility, would be 70 people, plus other Metro related staff. Construction would involve approximately 250 employees for 5 years.

Costs. Estimated capital costs for construction at Renton would be $157,200,000 (1976 dollars), as indicated in Table 3-13. Renton operation and maintenance would cost $5,370,000 per year. The effect of this on user charge is noted in the primary impact section, since user charges are determined on a Metro-wide basis. Impact of cost would be adverse, moderate, long-term, irreversible and definite.

Mitigation Measures

Several mitigation measures are suggested to aid in the reduction of adverse impacts resulting from the implementation of this alternative.

Pretreatment of industrial wastes could be provided before sewage enters the West Point plants. If current practices continue, influent to these facilities would occasionally contain slugs of cadmium, mercury and arsenic.

The possible silting over of salmon spawning grounds during the construction of the Kenmore parallel (Lake Line option) called for under Alternative C, would cause impacts, both environmental and economical. Chinook lake spawning occurs in water depths of one to eight feet where there is gravel, sand and groundwater seepage. Spawning occurs in autumn and intragravel development continues until early March. Timing construction to avoid impacts on salmon nests would restrict building activities to the six months of March through August. Therefore it is recommended that an evaluation study be made on the Force Main option to determine its possible impacts. Not enough information is presently available to consider this option. If the Lake Line option is selected, more detailed environmental analyses should be made of possible impacts of the pipe before construction begins.

Visual nuisance of the wastewater treatment facilities can be mitigated by (1) designing new facilities and additions to existing facilities utilizing natural geographical conditions (e.g., bluffs) and (2) landscaping the facilities.

Odor of the wastewater treatment facilities can be mitigated, in part, by not allowing the system to become anaerobic. Under anaerobic conditions, noxious gases such as methane and sulfur dioxide are emitted. Odor control measures for Alki are being investigated by Metro.

The energy impact can be in part defrayed by utilizing more of the methane gas which is produced by anaerobic digestion. Nearly half of this methane gas is flared off under current practices. Determinations have not been made regarding cost-effectiveness of methane storage and/or transport facilities.

Unavoidable Adverse Impacts

Under Alternative G, the following adverse impacts would be unavoidable.

- Construction impacts
- Sludge trucking
- Combined sewer overflows
- Land use changes
- Aesthetic nuisance of plant location
- Operation and maintenance (O & M) and capital costs
- Energy expenditures

For greater detail regarding unavoidable adverse impacts, the reader is referred to the preceding impact analysis.

ALTERNATIVE H
DECONSOLIDATION/RECLAMATION

The description of Alternative H and its projected impacts to the year 2005 are presented in this section.

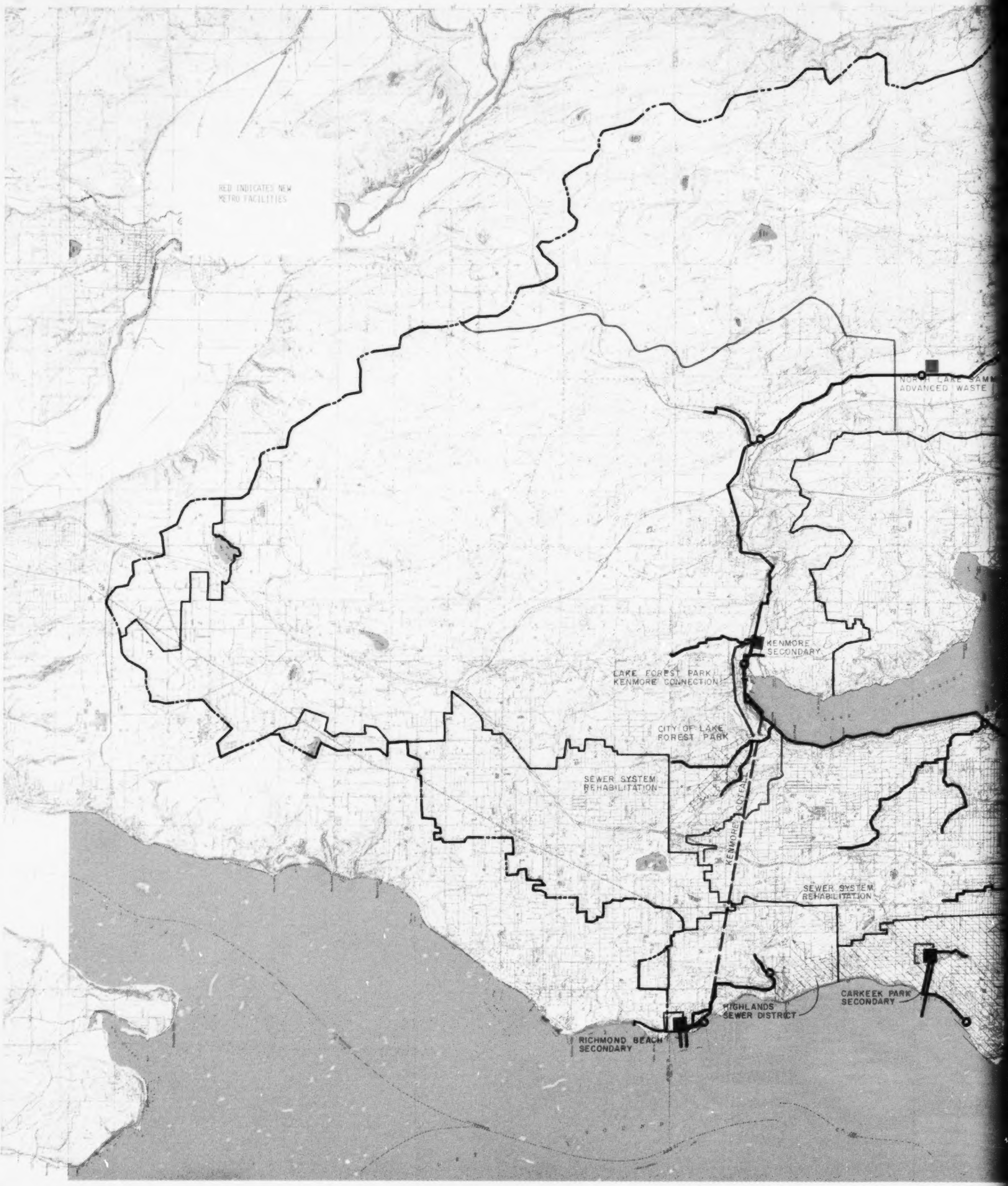
Description

Alternative H would provide secondary treatment at existing Puget Sound plants (West Point, Alki, Carkeek Park and Richmond Beach). Some deconsolidation would be made possible by providing new inland treatment plants to service local sewerage subareas by advanced waste treatment at North and South Lake Sammamish and secondary treatment at Kenmore.

Although this alternative is aimed at (1) deconsolidation to allow local rather than regional control of plant capacity to influence growth and (2) reclamation to allow sludge and effluent to be re-used, only limited progress toward these goals would result. Under Alternative H, local treatment plants at Richmond Beach, Carkeek Park, Alki, Kenmore, North Lake Sammamish and South Lake Sammamish would treat only 30 percent of the area's dry weather flow (excluding Renton service area); West Point, a regional plant, would treat the remaining 70 percent. If the Renton regional plant is included in the calculations, the local plant share in dry weather drops to 20 percent. The low share allocated to local plants in this alternative aimed at deconsolidation appears to result from the fact that a substantial commitment has already been made in the Metro area to regional wastewater facilities. A second comment on this alternative is that reclamation is an option, not a part of the proposed alternative.

The major wastewater facilities proposed for Alternative H are illustrated in Figure 3-19. Major features of the alternative are summarized in Table 3-34, including treatment plants, effluent discharges, combined sewer overflows, and major new transfer facilities. The construction schedule and costs for proposed facilities are shown in Table 3-35.

The alternative is further described below in terms of service area, treatment plants (location, treatment process, effluent disposal site), combined sewer overflow control, and


RED INDICATES NEW METRO FACILITIES
NORTH LAKE SAMM
ADVANCED WASTE
KENMORE SECONDARY
LAKE FOREST PARK KENMORE CONNECTION
CITY OF LAKE FOREST PARK
SEWER SYSTEM REHABILITATION
KENMORE OUTFALL
SEWER SYSTEM REHABILITATION
HIGHLANDS SEWER DISTRICT
CARKEEK PARK SECONDARY
RICHMOND BEACH SECONDARY

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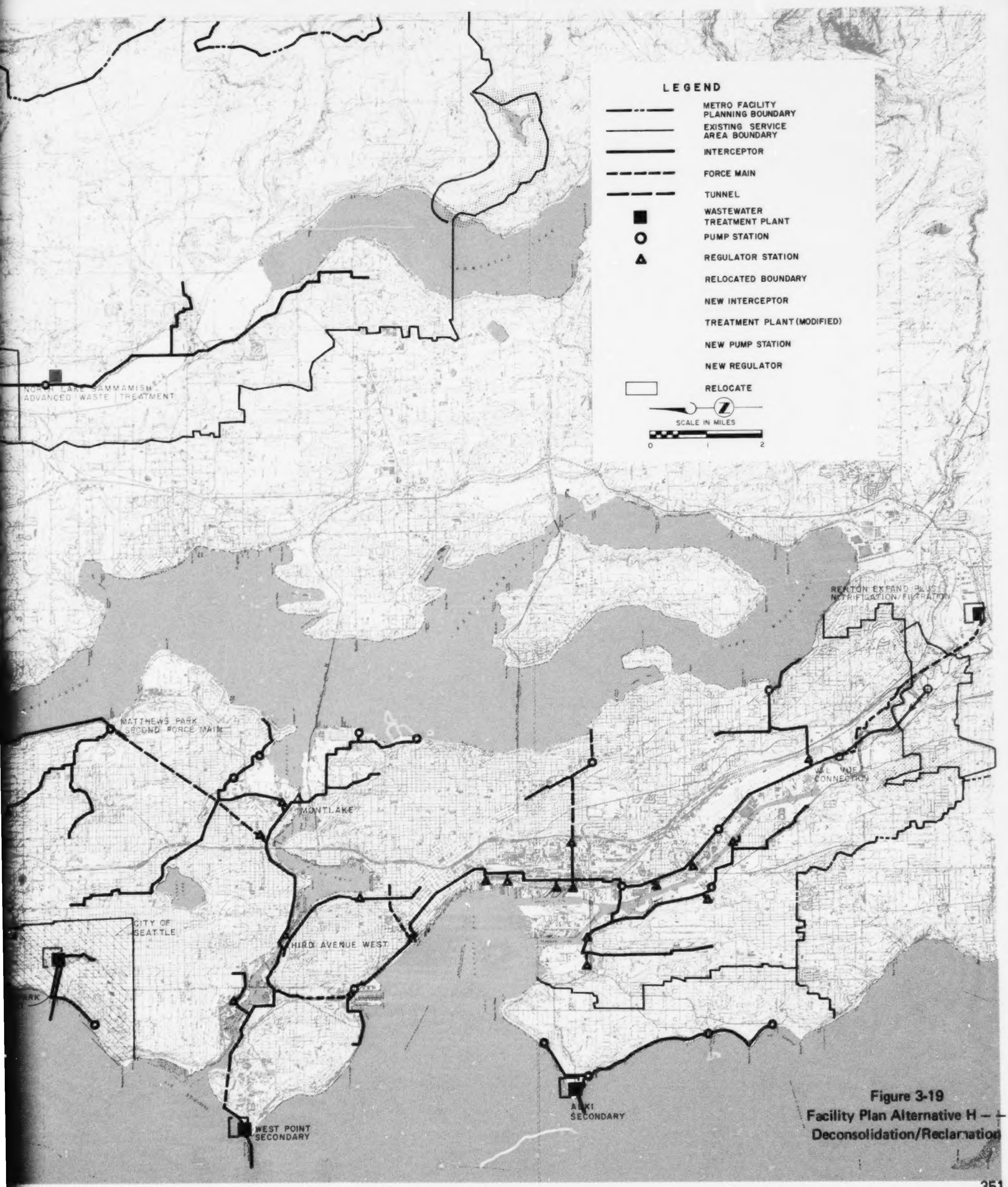

LEGEND
METRO FACILITY PLANNING BOUNDARY
EXISTING SERVICE AREA BOUNDARY
INTERCEPTOR
FORCE MAIN
TUNNEL
WASTEWATER TREATMENT PLANT
PUMP STATION
REGULATOR STATION
RELOCATED BOUNDARY
NEW INTERCEPTOR
TREATMENT PLANT (MODIFIED)
NEW PUMP STATION
NEW REGULATOR
RELOCATE
SCALE IN MILES
0
1
2
NORTH LAKE SAMMAMISH ADVANCED WASTE TREATMENT
MATTHEWS PARK SECOND FORCE MAIN
MONTLAKE
CITY OF SEATTLE
THIRD AVENUE WEST
WEST POINT SECONDARY
ALKI SECONDARY
RENTON EXPAND PLUS NITRIFICATION/FILTRATION
VAL VUE CONNECTION

Figure 3-19
Facility Plan Alternative H —
Deconsolidation/Reclamation

B

TABLE 3-34

ALTERNATIVE H - DECONSOLIDATION/RECLAMMATION

TREATMENT PLANTS

	WEST POINT	ALKI	CARKEEK PARK	RICHMOND BEACH	KENMORE		NORTH LAKE SAMMAMISH**	SOUTH LAKE SAMMAMISH**	RENTON*
Process	Secondary	Secondary	Secondary	Secondary	Secondary		Advanced Waste Treatment	Advanced Waste Treatment	Secondary plus Nitrification and Filtration
Improvements Complete	1985	1983	1985	1981	1983	1994	1988	1983	1995
Flow (mgd) 2005 (unless phased) average/peak	121/350	10/30	3.5/12.5	2.5/8		21/55	9/25	5/13	72/187
Disposal	Puget Sound	Puget Sound	Puget Sound	Puget Sound	Puget Sound (New Outfall at Richmond Beach)	Puget Sound (New Outfall at Richmond Beach)	Sammamish River or Lake Sammamish or Land	Lake Sammamish or Land	Duwamish

COMBINED SEWER OVERFLOW (2005)

	FLOW (Million Gallons/Yr)	SOLIDS (Tons/Yr)	BOD (Tons/Yr)
Lake Washington	19.1	17.4	4.76
Lake Sammamish	0	0	0
Portage Bay	210	205	50.2
Lake Union	48.3	43.8	12.0
Ship Canal	217	197	54.0
Elliott Bay	358	325	89
Alki Beach	5.46	4.95	1.36
Duwamish/Green River	251	227	62

TREATMENT PLANT DISCHARGE

	FLOW (Million Gallons/Yr)	SOLIDS (Tons/Yr)	BOD (Tons/Yr)
West Point	47,800	2,990	2,990
Alki Beach	3,650	228	228
Carkeek Park	1,530	957	957
Richmond Beach	912	57.1	57.1
Kenmore (via Richmond Beach outfall)	7,668	480	480
North/South Lake Sammamish	5,110	213	213
Renton	26,250	553	1,098

MAJOR NEW TRANSFER FACILITIES

Location	Year Completed
Lake Forest Park - Kenmore Connection	1983
Val Vue Connection to West Point	1980
West South Lake Sammamish to South Lake Sammamish Plant	1983

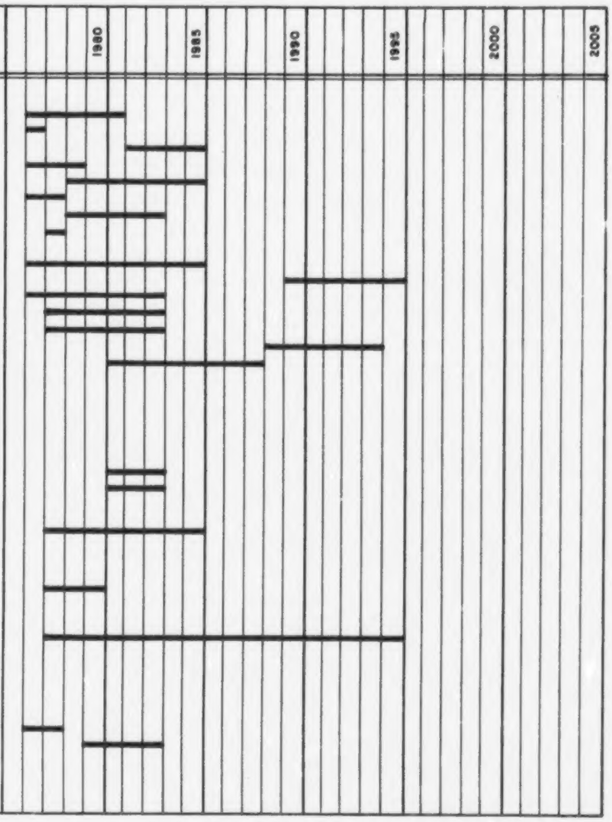
*Not included in proposed facilities plan for Puget Sound plants

**Enhanced primary (physical/chemical), secondary, nitrification, denitrification, granular carbon adsorption, filtration, ion exchange

Table 3-35

Alternative H -- Project Costs and Construction Staging

Facility Component	Project Cost $ million ENR-CCI 2600
Treatment Plants Including Outfalls	
Richmond Beach - Add Secondary Treatment	6.0
Carkeek Park - Interim Improvements	0.1
Carkeek Park - Add Secondary Treatment	8.3
West Point - Interim Improvements	4.8
West Point - Add Secondary Treatment	101.2
Alki - Interim Improvements	0.3
Alki - Add Secondary Treatment	26.2
* Renton - Interim Improvements	0.4
* Renton - Enlargement II and Upgrading (Nitrification, Filtration, Sludge)	51.0
* Renton - Enlargement III (South Lake Sammamish AWT Plant)	31.7
Kenmore - Secondary Plant Stage 1	30.0
Kenmore - Outfall	37.2
Kenmore - Plant Stage 2	6.0
North Lake Sammamish AWT Plant	37.0
Subtotal - Treatment Plants	361.2
Collection System	
Accommodate Service Area Change	
Lake Forest Park-Kenmore Connection	1.4
West S.L.S. to S.L.S. Plant	1.5
Rehabilitation of Existing Collection System	18.0
* Increased Transfer Capacity within West Point Existing Sewered Areas	
Val Vue Connection to West Point	5.5
Increased Transfer Capacity and Rehabilitation within Renton Existing Sewered Area	13.4
Subtotal - Collection System	39.8
Combined Sewer Overflow Control	
Montlake Regulator Station	0.8
Third Ave. W. Regulator Station	0.5
Subtotal - Hold & Transport CSO	1.3
Total Capital Cost	402.3



*Renton facilities not part of proposed facilities plan.

sludge management. The indirect impacts of the facilities proposed under this alternative on the Renton plant are also described.

Service Area

The service areas of Alternative H would be as shown in Figure 3-1. Major changes include serving new growth in northern and eastern sewerage service subareas by three new treatment plants: (1) the North Lake Washington and part of the Northwest Lake Washington subarea, (2) the North Lake Sammamish subarea, and (3) the South Lake Sammamish subarea. The West Point service area would be reduced correspondingly. Alki, Richmond Beach and Carkeek Park subareas would not change. The new transfer interceptors that would be needed to facilitate the service area modifications would be the Lake Forest Park connection to Kenmore (1983), West Lake Sammamish connection to South Lake Sammamish (1983), and Val Vue connection to West Point (1980).

Construction schedule for these collection systems modifications would be as shown in Table 3-35.

Treatment Plants

The wastewater treatment facilities under Alternative H would be as shown in Table 3-34.

The new North and South Lake Sammamish plants would provide advanced waste treatment according to process steps that the facilities planning engineers believed were necessary before discharging effluent to inland waters. Advanced waste treatment processes would include (1) enhanced primary (physical/chemical) treatment for settling, (2) secondary treatment for solids and organics removal, (3) nitrification for converting ammonia-nitrogen to nitrates, (4) denitrification for converting nitrate to nitrogen, (5) granular carbon absorption for organics removal, (6) filtration for solids removal, (7) ion exchange for reducing salt content, (8) chlorination for disinfection and (9) dechlorination to remove chlorine.

The exact location of the Lake Sammamish plants has yet to be determined. The North Lake Sammamish site would be approximately as shown in Figure 3-19; the South Lake Sammamish plant would be located on the south shore of Lake Sammamish.

The North Lake Sammamish plant, which would be completed in 1988, would treat 9 mgd average, 25 mgd peak flows. A sample plant layout for the advanced waste treatment is shown in Figure 3-20. Treated wastewater would be discharged to the Sammamish River (flowing out from Lake Sammamish) or to land for beneficial re-use.

The South Lake Sammamish plant would be completed in 1983 to treat 5 mgd average, 13 mgd peak flows. Effluent would be discharged to Lake Sammamish or to land for re-use.

Since re-use is an option but not part of the proposal for the North and South Lake Sammamish plants, reclamation by advanced waste treatment would not be required for disposal to land.

The Kenmore plant, to be constructed in two stages (1983 and 1994), would provide an ultimate capacity of 21 mgd average, 55 mgd peak flow for the growth anticipated in the North Lake Washington sewerage service subarea. The layout for the Kenmore plant is shown in Figure 3-21 and the approximate site location is contained in Figure 3-19. Secondary effluent would be transferred to Richmond Beach, then discharged through a new outfall there to Puget Sound. Thus, advanced waste treatment would not be necessary at Kenmore.

In 1985, the West Point plant would provide secondary treatment by air activated sludge for 121 mgd average, 350 mgd peak flow. Discharge to Puget Sound would be through the existing outfall. For this capacity, 12 acres of shoreline fill would be required. The layout would be as in Alternative E (Figure 3-14).

Richmond Beach would provide secondary treatment (air activated sludge) by 1981 and discharge to Puget Sound through the present outfall, to be paralleled by the new Kenmore outfall. The secondary facilities for 2.5 mgd average, 8 mgd peak flows, would fit on existing property, as shown in Alternative E.

At Alki, secondary air activated sludge treatment by 1983 for 10 mgd average, 30 mgd peak flows would require expansion into the adjacent ballfields. The plant layout would be as shown in Figure 3-14.

At Carkeek Park, the plant would be upgraded to secondary, air activated sludge treatment by 1985. Treated 3.5 mgd average, 12.5 mgd peak flows would be discharged through the existing outfall to Puget Sound. The enlarged plant, shown in Figure 3-22, would expand into a picnic area in the park.

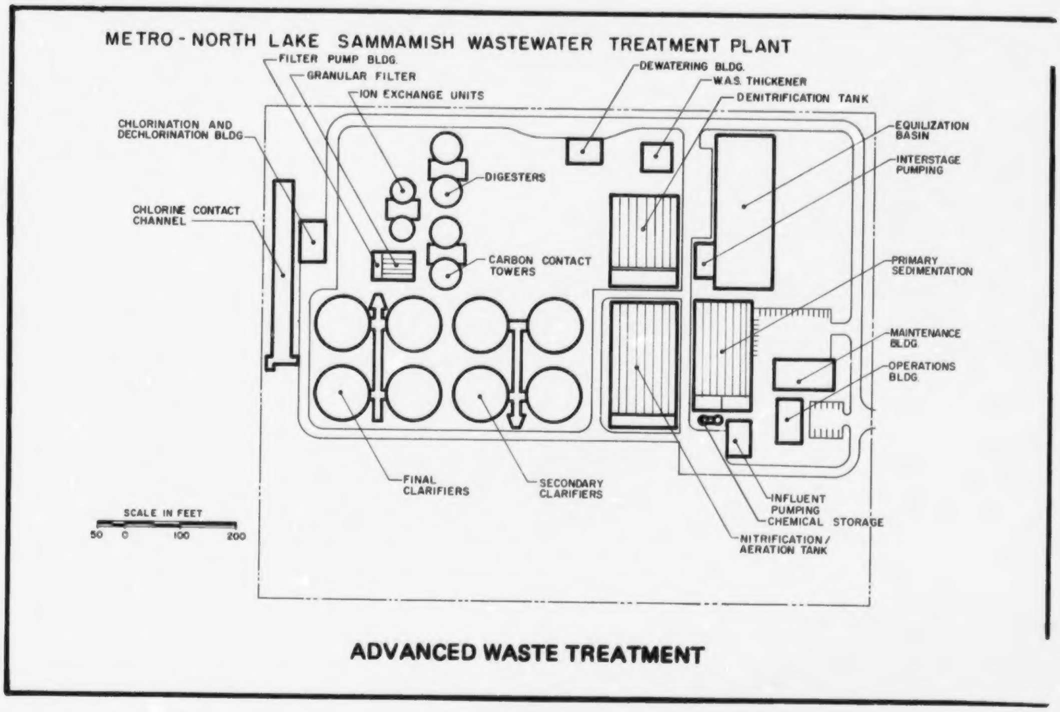

METRO - NORTH LAKE SAMMAMISH WASTEWATER TREATMENT PLANT
FILTER PUMP BLDG.
GRANULAR FILTER
ION EXCHANGE UNITS
DEWATERING BLDG.
W.A.S. THICKENER
DENITRIFICATION TANK
CHLORINATION AND DECHLORINATION BLDG.
EQUILIZATION BASIN
INTERSTAGE PUMPING
DIGESTERS
CHLORINE CONTACT CHANNEL
CARBON CONTACT TOWERS
PRIMARY SEDIMENTATION
MAINTENANCE BLDG.
OPERATIONS BLDG.
FINAL CLARIFIERS
SECONDARY CLARIFIERS
INFLUENT PUMPING
CHEMICAL STORAGE
NITRIFICATION / AERATION TANK
SCALE IN FEET
50
0
100
200
ADVANCED WASTE TREATMENT

Figure 3-20
Alternative H
North Lake Sammamish Wastewater Treatment Plant

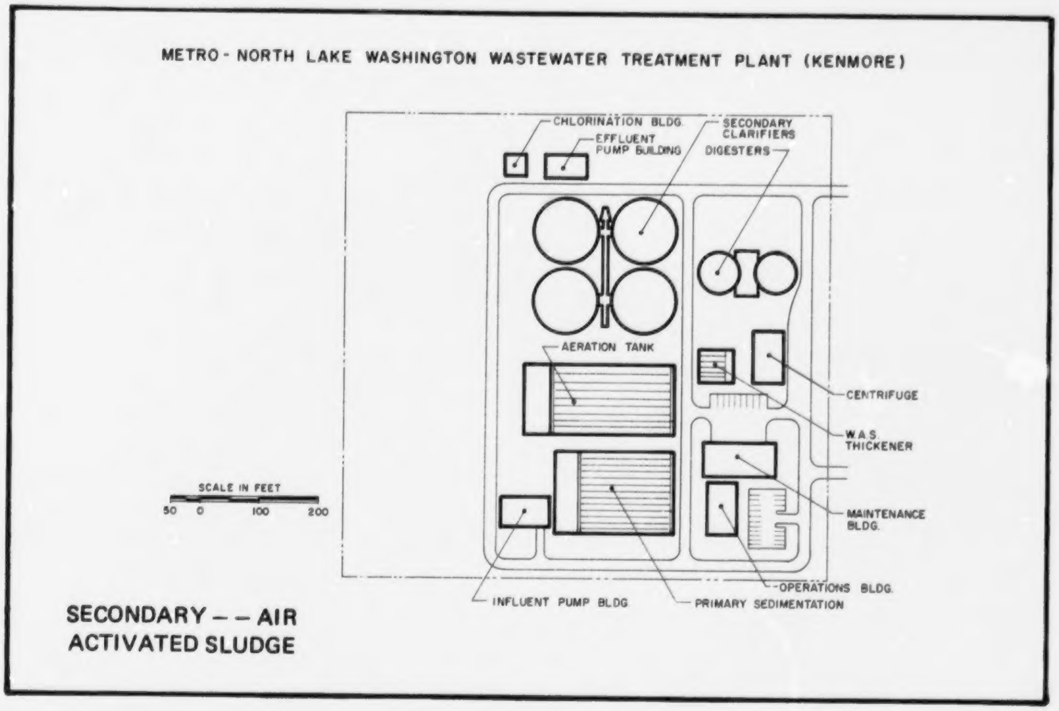

METRO - NORTH LAKE WASHINGTON WASTEWATER TREATMENT PLANT (KENMORE)
CHLORINATION BLDG.
EFFLUENT PUMP BUILDING
SECONDARY CLARIFIERS
DIGESTERS
AERATION TANK
CENTRIFUGE
W.A.S. THICKENER
MAINTENANCE BLDG.
OPERATIONS BLDG.
INFLUENT PUMP BLDG.
PRIMARY SEDIMENTATION
SCALE IN FEET
50 0 100 200
SECONDARY – – AIR
ACTIVATED SLUDGE

Figure 3-21
Alternative H
North Lake Washington (Kenmore)
Wastewater Treatment Plant

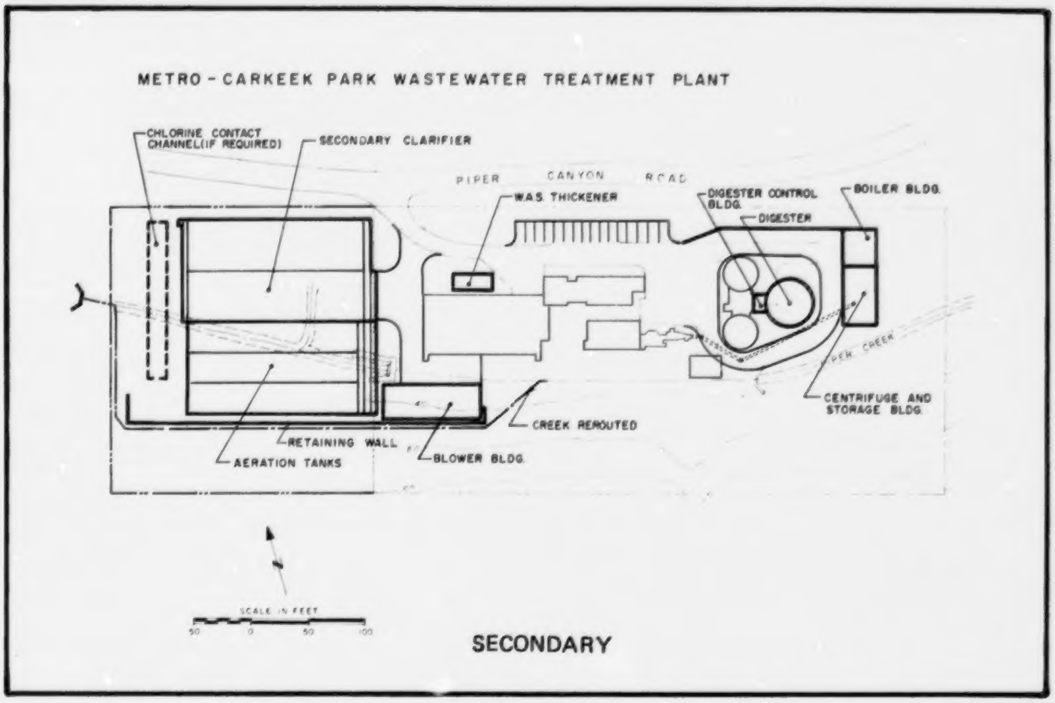

METRO - CARKEEK PARK WASTEWATER TREATMENT PLANT
CHLORINE CONTACT CHANNEL(IF REQUIRED)
SECONDARY CLARIFIER
PIPER CANYON ROAD
W.A.S. THICKENER
DIGESTER CONTROL BLDG.
DIGESTER
BOILER BLDG.
PIPER CREEK
CENTRIFUGE AND STORAGE BLDG.
CREEK REROUTED
RETAINING WALL
BLOWER BLDG.
AERATION TANKS
SCALE IN FEET
50
0
50
100
SECONDARY

Figure 3-22
Alternative H
Carkeek Park Wastewater Treatment Plant

All secondary treatment plants would provide dechlorination before discharge.

Combined Sewer Overflow Control

In Alternative H, combined sewer overflows would be reduced 6 percent relative to Alternative B. The flows to more sensitive inland waters (Lake Washington, Portage Bay, Lake Union, and the Ship Canal) would decrease by 8 to 15 percent, presumably due to transfers of flow in northern and eastern growth areas from West Point to the new inland plants. Construction of the Montlake and Third Avenue West regulator stations is assumed in this alternative.

Sludge Management

The sludge management system for Alternative H would include anaerobic digestion at all plants, with methane used to the extent possible. Renton sludge would be removed from West Point and treated at Renton. Richmond Beach digested sludge would be trucked to West Point for dewatering. Dewatered sludge from Carkeek Park, West Point, and Alki would be trucked to Cedar Hills landfill and Park Forest. There is a possibility for local sludge re-use as a soil amendment from the three new inland plants in part because metals from industry would not be tributary to the plants.

Renton

Although the Renton service area and treatment plant are not included in the proposed facilities for Alternative H, the alternative would have indirect impacts on the Renton plant. To handle projected growth in its service area, although smaller than in all other alternatives, the Renton plant would be expanded in two stages (1985 and 1995) to 72 mgd average, 187 peak capacity. In addition, the plant would be upgraded by nitrification and filtration prior to discharge to the Duwamish. Sludge would be anaerobically digested at Renton, dewatered, and trucked to Cedar Hills landfill or Pack Forest.

Primary Impacts

The direct impacts from this alternative for the West Point, Alki, Carkeek Park, Richmond Beach, Kenmore, North and South Lake Sammamish plants are described below in terms of effects on geology, soils and topography; air quality and odors; water quality; biology; energy and natural resources; and the human environment. Indirect impacts from this alternative and the effects of Renton discharge are summarized under a later section on secondary impacts.

Geology, Soils and Topography

The impacts of plants in the Kenmore area and the Sammamish River valley cannot be assessed until specific sites are chosen. However, it is known that the Sammamish River valley floor is composed of alluvial soils which are not sufficiently stable to support large structures. The entire valley floor also lies within the ten-year flood plain as defined by the U.S. Army Corps of Engineers. Construction of a treatment plant in this area would probably require raised foundations and piling support. Earthquake damage potential in these areas could also be significant.

The site-specific impacts on slopes and stability and from erosion and/or deposition would be minor, of limited extent, and of short duration. Because exact sites have not been chosen, such impacts are included in this regional rather than in site-specific documents. Sludge disposal site impacts would not be expected to change radically from their existing situation, although the sludge deposition rate would accelerate with improved solids removal. At Cedar Hills, the 30 year useful life of the landfill could be reduced by about one year with disposal of larger sludge volumes there from secondary and more advanced wastewater treatment. Impacts would be monitored at Cedar Hills and the Park Forest site. If sludge from the North and South Lake Sammamish plants is applied to land for re-use, impacts on soils should be investigated.

Air Quality and Odors

Trucking sludge from Richmond Beach to West Point and from West Point, Alki, Carkeek Park and Renton to the

Cedar Hills landfill would emit approximately 520 grams of hydrocarbons, 3230 grams of carbon monoxide, and 2350 grams of nitrogen oxides per day. Treatment plant personnel traffic would generate approximately 6815 grams of hydrocarbons, 86715 grams of carbon monoxide, and 11235 grams of nitrogen oxides daily. Combined emissions would amount to less than 0.01 percent of Seattle's total daily emissions of hydrocarbons, carbon monoxide, and nitrogen oxides. Implementation of Alternative H would have a negligible, long-term, adverse, reversible impact on air quality in the Seattle area. Sludge trucking to Park Forest would generate more air pollutants than traffic to the Cedar Hills site (located closer to sludge treatment facilities), but the overall impact on air quality would remain negligible.

With the upgrading of the Richmond Beach, Carkeek Park, West Point and Alki plants to secondary treatment, the likelihood of odors escaping in these areas would increase. Because secondary treatment plants are larger and more complex than primary plants, expose more water surface area to the air and subject the water to more perturbation, there is a greater likelihood for odors being released into the surrounding neighborhood from secondary treatment plants. The potential for odors would also be increased in the neighborhoods adjacent to the new advanced waste treatment plants in Kenmore and North and South Lake Sammamish. The potential for odors being released from advanced waste treatment plants is even greater than that for secondary treatment, because the advanced plants are more complex, subject the water to more turbulence, and offer more opportunities for odors to escape. Various practical measures can be employed, however, to control treatment plant odors and are discussed in the section on mitigation measures. Odor control at Alki is being investigated now by Metro.

Because the volume of CSO's would increase 15 percent at Lake Washington, Lake Union and the Ship Canal relative to Alternative B, the odors arising from CSO's will also increase. The potential odor problems associated with this alternative would be a minor, long-term, adverse, reversible impact on the environmental quality of the metropolitan Seattle area.

Water Quality

The construction of advanced waste treatment plants at North and South Lake Sammamish, a secondary treatment plant in Kenmore, and upgrading the West Point, Alki, Carkeek Park and Richmond Beach plants to secondary treatment would have mixed impacts on water quality.

Lake Washington. With new treatment plants constructed at Kenmore and at North Lake Sammamish the West Point service area would be reduced so that the yearly volume, solids, and BOD of sewer overflows to Lake Washington would decrease by approximately 15% relative to Alternative B. Thus combined sewer overflow's localized impacts on water quality (nutrients, bacteria, toxicants) would be similar to Alternative B but to a lesser degree.

Effluent from the North Lake Sammamish plant would contain some nitrates (less than 0.1 mg/l) even after advanced treatment. If the plant discharged into the Sammamish River, the nitrate load downstream in Lake Washington would be incrementally increased. If the North Lake Sammamish plant were to discharge to the Sammamish River, the mean annual effluent flow to Lake Washington would be about 3,285 million gallons, or more than 170 times as much as the yearly future volume of CSO's to Lake Washington.

The nutrient addition to Lake Washington via the Sammamish River could have an enrichment effect of undetermined magnitude. The plant would be discharging flows equal to 20 percent of river summer low flows, 3 percent of winter peak flows and 5 percent of average Sammamish River flow. The nutrient level would be the same as or lower than in river water, but the total nutrient load would increase.

With the North Lake Sammamish plant discharge and combined sewer overflows to Lake Washington, the nutrients in the lake could exceed DOE standards for lake class waters of 0.1 mg/l nitrate-nitrogen and 0.05 mg/l phosphate. Assuming the Madison Park overflow sample (Metro 1976) is typical of CSO quality, CSO's could contain 0.11 to 0.96 mg/l nitrate and 0.98 to 5.53 mg/l total phosphate. Thus, localized areas could at times exceed state recommended nutrient levels as a result of combined sewer overflows, and the lake would receive incremental nutrient loads from CSO's. Nitrates and phosphates levels in the tertiary effluent from the Sammamish Valley STP would probably be less than 1 mg/l although predictions of effluent quality are not firm. Assuming a 10:1 to 100:1 dilution in the Sammamish River, Lake Class criteria would be met. The total nutrient load from the effluent would be far greater than from combined sewer overflows. The effect of both together would be moderate due to the load increase, and extensive because the entire lake would be affected. Impacts would be irreversible, because the total nutrient load of the lake would be increased and long-term because the discharges would continue through the planning period.

Lake Sammamish. The adverse impact on Lake Sammamish water quality of an average of 5 mgd tertiary treated effluent from a South Lake Sammamish plant would probably be minor, because the discharge would be small relative to the size of the lake (855,000 million gallons) and highly treated. Effects would be extensive (because wide areas of the lake could be affected), long-term (because the discharge would continue through the planning period) and reversible. The effect would probably be due to the increased nutrient load to the already eutrophic lake. Like Lake Washington, state nutrients criteria for Lake Sammamish are less than 0.1 mg/l for nitrate, and less than 0.05 mg/l for phosphate. While phosphate standards are apparently not violated at present, the total phosphorus concentration in the lake during the winter through early spring months is the nutrient source for the spring algae bloom. The presence of nutrients is not believed to be of itself the controlling factor of algae production in Lake Sammamish, however. Contemporary thought suggests that the high amounts of iron in the lake scavenge phosphorus from the water column and recycle only a portion to the surface waters during overturn. Nitrates concentrations exceed criteria annually in winter and spring. It is assumed that effluent limitations for the South Lake Sammamish plant will take the lake's dilution and mixing into account, such that nutrient concentrations in the lake do not increase to levels exceeding established criteria. The effluent would, however, increase the total nitrogen and phosphorus load to the lake by a minor amount.

Lake Union/Ship Canal. The volume, solids, and BOD loadings from CSO's to Lake Union and to the Ship Canal would be reduced by about 15%, relative to the Alternative B. The overall adverse effect of continued overflows would be minor, because the flows are not large, and of limited extent. Except for the accumulation of pesticides, PCB's and heavy metals, the impacts are reversible.

Cedar and Green Rivers. No impact on these waters is expected under Alternative H.

Sammamish River. The North Lake Sammamish plant would discharge an average of 9 mgd (25 mgd peak flow) to the Sammamish River, which has about 174 mgd on the average, low flows of about 46 mgd, and peak flows of about 840 mgd. Thus, effluent from the proposed plant would represent about 5 percent of the average flow. In summer, when phosphorus violations apparently occur, effluent would be 20 percent of the river flow. Sammamish Valley effluent would be 3 percent of flow in winter when nitrates violations occur.

The effluent could have an adverse impact on summer water quality. The temperature of the effluent may be higher than that of the receiving water, unless cooling methods are included in treatment, and could increase the river's temperature by one degree Fahrenheit. Summer water temperature now approaches and occasionally exceeds 68° F, the maximum tolerable limit for migrating salmon (Metropolitan Engineers Task Report D5, 1977), and exceeds the 60° F DOE Class AA standard for the river. The effect of the warmer effluent would also be negative, as meeting established standards would be even more difficult. The overall thermal impact would be minor, extensive in the river and of short duration.

South Lake Sammamish discharge would have to meet DOE nutrient standards for less than 0.3 mg/l nitrates and for less than 0.1 mg/l phosphates. The Sammamish River exceeds 0.3 mg/l nitrate most of the year by a factor of two to four (STRRIBCO Part III Appendix B, November 1974), and phosphate criteria are exceeded annually in late summer. The effluent would add to the nutrient load of the river. The adverse impact from this would be minor, (because the discharge would continue through the planning period) and reversible (because the river can flush itself).

Effluent would be lower in Coliform bacteria than the river.

Duwamish estuary. Under Alternative H, impacts of combined sewer overflows to the Duwamish would be as described previously under Alternative B. Projected CSO annual flows, solids and BOD loads to the Duwamish would be 1, 41 and 6 percent of the Renton plant discharge. Thus, except for localized areas and some effects associated with solids, CSO impacts on the Duwamish would be less than from the Renton plant.

Puget Sound. Since Alternative H includes secondary treatment at all Puget Sound plants, a new Alki outfall and no CSO reduction, impacts on Puget Sound water quality would be similar to those of Alternative E. Minor reductions in flow by shifting some wastewater service areas to inland plants are not expected to measurably change water quality impacts in Puget Sound. Very minor reductions in nutrients from secondary treatment would be offset by increased contribution from CSO's for a net minor and long-term impact on beach, nearshore and offshore waters. Suspended solids loads on beaches would be reduced in extent. Remaining impacts from suspended solids would be minor (because the suspended solids content of receiving waters is not greatly increased), long-term (because the discharges would continue through the planning period), and reversible. For more detail, Alternative E impacts should be consulted. Major changes relative to Alternative E would be Kenmore plant discharge off Richmond Beach, Carkeek Park secondary effluent discharge, and reductions in West Point discharge. The site specific EIS (Volume II) contains more detail on these impacts.

Groundwater. The proposed North and South Lake Sammamish treatment plant effluent could be re-used for groundwater recharge. Such recharge would probably infiltrate into the Redmond well fields, but this recharge water quality would be high. Nitrogen levels are expected to be below the concentrations that can cause health problems. Viruses would be removed by the treatment plant's disinfection, and more would be removed by the soil. Organics removal would be promoted by activated carbon before recharge. Both local and national research is in progress on the impacts of groundwater recharge and its potential for various end uses.

Pack Forest researchers would continue studying the impacts of groundwater recharge with wastewater. Tentative conclusions to date are that groundwater recharge with secondary effluent is feasible under certain conditions (Cole and Scheiss, 1977).

Research problems should be addressed in more detail in site specific EIS documents prepared later, in the event that inland treatment plants are recommended.

Flood hazard. The entire Sammamish Valley is within the ten year flood plain as defined by the U.S. Army Corp of Engineers. Table 3-36 shows the 100 year flood levels at the proposed sites for Alternative H.

Table 3-36

100 Year Flood Water Levels

Site	Flood Level (feet)	Ground Surface (feet)	Depth to Water Level (feet)
Kenmore	16	25	9
North Lake Sammamish	32.5	25.5	0
South Lake Sammamish	32.5	25.5	0

Note: Elevations are in feet above mean sea level; since plant locations have not been selected, elevations are approximate.

The Kenmore site would have little risk from flood water. However, at the North Lake Sammamish and South Lake Sammamish sites, precautions should be taken, possibly including raised foundations and structural barriers around the facility. If floodwaters were to wash away the facility's untreated sewage, it could degrade surface water quality. Sludge basins, which are usually below the elevation of the rest of the facility, should be protected.

Biology

Biological impacts of treatment plant construction, effluent discharge and CSO's are described below.

Terrestrial habitats. Terrestrial biota would be permanently displaced and probably lost from the two sites of the advanced waste treatment plants and perhaps the Kenmore plant. Until sites are chosen, it is difficult to say which habitat type would be affected. The area is generally rural-suburban in nature; native plants and trees are the dominant vegetation. The construction of the facilities would permanently eliminate a small portion of this habitat, and create noise and dust that would temporarily frighten off birds and mammals. The impact of construction activities is considered to be moderate, but highly limited in extent and of short duration. Impacts of noise and dust are considered to be reversible; animals would probably return when construction was completed. Areas with new structures would be irreversibly altered. The effect on those sites would be severe and of long duration but highly limited in extent.

Impacts at the West Point, Richmond Beach and Alki areas would be as described under Alternative E. Approximately 1.1 acres of grassy habitat would be used for secondary treatment facilities at Carkeek Park.

Shoreline habitats. Marshes at Lake Washington and the Ship Canal would receive slightly reduced levels of overflow loads and flows (15 percent) compared to Alternative B. The benefit of Alternative H is considered to be probably very minor, fairly extensive as most marshes are subject to overflows, and of long duration as overflows are continuing phenomena.

The intertidal. Overflows to the intertidal at Alki/ West Seattle and Elliott Bay would be as described under Alternative B. Assuming treatment plant effluent reaches beach areas near each of the four outfalls at least occasionally, effluent volume and quality is still a concern. Under Alternative H, flows would be similar to Alternative B, as would nutrient levels as these parameters (especially nitrates) are not removed in significant amounts by secondary treatment.

Richmond Beach is an exception in that flows from the new Kenmore (North Lake Washington) secondary plant would enter Puget Sound through an outfall at this point. The new combined flows and loads of BOD and suspended solids would be approximately nine times the Richmond Beach discharge under Alternative B. No measurable effects of effluent on the intertidal have been found at this site; whether or not increased flows and loads would have an effect cannot be determined.

At the other outfall sites, loads of solids and BOD (and associated metals and toxicants), would be significantly reduced by about 72 and 80 percent respectively. The nutrient impact on the intertidal would be essentially as in baseline levels except that assumed at Alki. The outfall would be improved probably reducing effluent impact on the intertidal.

A major reduction in metals in effluent from secondary treatment could mean that clams and algae at West Point and other outfall areas could decline to background levels (such as detected at Point No Point). Since standards for metals have not been exceeded anywhere in the study area, the benefit is minor-to-moderate, but possibly extensive and certainly of long duration.

As CSO's would continue at baseline flows and loads, pathogen inputs could be at present levels, wherein bacterial levels in the intertidal waters exceed state fecal coliform standards for shellfish waters. Treatment plant discharges of secondary effluent would receive more effective disinfection than under Alternative B. However, since the source of bacteria in the intertidal has not been identified, it cannot be determined whether or not coliform standards for shellfish waters would be met under Alternative H. Shellfish consumption could continue to represent a potential public health risk. The construction of a new outfall at Richmond Beach to carry flows from the Kenmore plant would affect a limited portion of the intertidal. These impacts are discussed in the Richmond Beach site document which is Volume II of this series.

Puget Sound. Effects of nutrients on phytoplankton productivity extremes would increase slightly relative to Alternative B. Levels of metals in plankton near West Point would probably decrease, however, representing a minor benefit, limited in extent, but of long duration (since those metals would no longer enter the Puget Sound food web and be concentrated.

A major reduction in solids and BOD could reduce the magnitude of effects on benthic community abundance and diversity. Organisms most involved would be clams and worms, which are deposit and/or suspension feeders.

Commercial and sport fisheries. Overflows to Lake Washington and the Ship Canal would decrease by 15 percent relative to Alternative B, but the fish run could be affected by discharge of effluent from the North Lake Sammamish plant into the Sammamish River. The effluent from the North Lake Sammamish plant would be designed to meet discharge standards, but would probably be of a higher temperature than the river water in summer. The effect would be to raise the river temperature by 1 to 2°F, which could be significant as the river is already at temperatures intolerable to summer fish migrations. The adverse effect on fish populations could probably be major and extensive, and cause a long-term decrease in fish population. The effect is considered to be reversible. Furthermore, any malfunction of the plants discharging to Lake Sammamish or the Sammamish River could discharge untreated or incompletely treated effluent, which could affect juvenile fish and adults migrating in the system.

Since the Elliott Bay - Duwamish - Green River fish migration route would be subject to sewer overflows at the same levels as Alternative B, Alternative H would cause no changes in effects.

Effects from CSO's on eelgrass beds and other nearshore areas where larval and juvenile fish tend to congregate and feed would be as in Alternative B, as CSO inputs would continue unabated. Effects of secondary treatment of effluent could mean reduced exposure of sensitive larval and juvenile fishes and invertebrates (such as shrimp and crabs) to metals and toxicants. These parameters are not known to be a problem at present, however.

The Duwamish estuary. Sewer overflows loads and flows would be as in baseline conditions, (Alternative B), so Alternative H would have no further direct impact.

Freshwater environments. In this alternative Lake Sammamish and Sammamish River biota would be affected by effluents from inland treatment facilities. In addition, CSO reductions to other freshwaters would be abated only slightly or not at all.

1. Lake Washington. Impacts from combined sewer overflows would be essentially the same as Alternative B, as CSO's are reduced only 15%.

2. Lake Sammamish. Additional nutrient loads from the wastewater treatment plants (South Lake Sammamish and possibly North Lake Sammamish) could have an adverse effect on the lake. Although evidence to date indicates the lake is becoming less eutrophic (overfertilized) than it was prior to Metro sewage diversions from the lake in 1965, dense plankton blooms have continued. The enrichment situation is also shown by the abundance of certain insect larvae (Chironomidae), for which development correlates with algae production and low dissolved oxygen levels.

As a result, any additional nutrient load would be considered to have an adverse impact. The South Lake Sammamish plant and possibly the North Lake Sammamish could add to the nutrient load of this already eutrophic lake, slightly but surely degrading the water quality and thus affecting its biota. The enhancing effect on the algal productivity of the lake is judged to be a negative and long-term impact as the lake is poorly flushed (water residence time is over two years). The effect would probably be minor, as the nutrient load would be small from a plant employing advanced waste treatment, but would be extensive in the lake. For most parameters, the effluent would dilute the lake water. The effluent may be of a slightly higher temperature, but this is not considered to be a problem (Metropolitan Engineers, 1976).

3. Lake Union/Ship Canal. Overflows to these waters would decrease about 15% relative to Alternative B. Improvement would be very minor even at overflow points, and the biota would continue to be those characteristically tolerant of somewhat degraded water quality. The influence of CSO's on overall water quality is unknown.

4. Sammamish River. Effluent from the North Lake Sammamish plant has a higher temperature than the river and could raise the river's temperature 1° to 2°F, an unacceptable increment in summer as salmon temperature requirements are already exceeded. Cutthroat trout and steelhead migrating downstream would also be subject to the higher temperatures. The small nutrient load could also affect Lake Washington downstream. The temperature impact could be major, and extensive, and cause a long-term decrease in fish populations. The effect is considered to be reversible. In the event of any plant malfunction, untreated or incompletely treated effluent discharged from a plant to the Sammamish River or Lake Sammamish could affect juvenile fish or adults migrating in the system.

5. Cedar River, Green River and other waters. No impacts are expected.

Rare and endangered species. No impacts are expected as no listed species are recorded from the study area. Sensitive habitats have been discussed previously.

Energy and Natural Resources

Energy. For Alternative H, a net of 124 million equivalent kwh/year of energy would be consumed by 2005 by all plants except Renton. Included would be 88 million kwh/year of electrical energy purchased. This is equivalent to the amount of electrical energy 4400 households would consume per year, and constitutes approximately 0.44 percent of the projected electrical energy consumption of Seattle in 2005 (Appendix E).

Table 3-37 shows the breakdown of total energy consumption on a plant-by-plant basis. The greatest energy consumption would be in the form of electricity. Chemicals account for about 5-15 percent of energy consumption, and sludge trucking for less than 12 percent. In the anaerobic digestion of sludge, there would be a net production of energy because of methane formation.

The impact of the energy consumption would be adverse, moderate-to-high in magnitude, long-term, irreversible and definite.

Chemicals. On a regional basis, plants in 2005 would consume 2515 tons of chlorine for disinfection; 760 tons of sulfur dioxide for dechlorination; 4,580 tons of lime, 500 tons of ferric chloride, 655 tons of alum and 44 tons of polymer for solids removal and handling; 1,155 tons of methanol for denitrification; 11,490 tons salt for recharging ion exchange materials; and 190 tons of activated carbon for organics removal. Details by plant are shown in Table 3-37.

The impact of chemical usage would be adverse, moderate, long-term, irreversible and definite. The supplies of chlorine, sulfur dioxide, alum, polymer, methanol, and sodium chloride are highly reliable. Lime and ferric chloride are in moderate supply. The closest source of activated carbon would probably be Marshall, Texas.

Human Environment

Alternative H would install advanced wastewater treatment plants at North Lake Sammamish and South Lake Sammamish and Kenmore, which could influence population growth in these areas. This alternative meets the requirements of PL 92-500.

Land use. Land would have to be made available for the new facilities at Kenmore, North Lake Sammamish, and South Lake Sammamish and for expansion of facilities at Carkeek Park, West Point, Richmond Beach, and Alki. At West Point, 12 acres of shoreline fill would be required. Rights-of-way would be required for construction of the Lake Forest Park

TABLE 3-37

ENERGY AND CHEMICAL CONSUMPTION FOR ALTERNATIVE H

	PLANT							
	Richmond Beach	Carkeek Park	West Point	Alki	Kenmore	N.L. Sammamish	S.L. Sammamish	Total
Onsite Energy								
Purchased electricity (kwh x 10^6/yr)	2.20	2.81	56.13	6.07	13.72	4.64	2.63	88.20
Produced by digestion (kwh x 10^6/yr)	0.42	0.73	15.31	1.28	2.71	1.77	1.01	23.23
Consumed by digestion (kwh x 10^6/yr)	0.17	0.29	6.12	0.51	1.08	0.71	0.40	9.28
Offsite Energy								
Chemical (kwh x 10^6/yr)	0.12	0.25	10.73	0.59	1.39	21.79	13.61	48.48
Sludge Trucking (kwh x 10^6/yr)	0.10	0.03	0.92	0.03	0.18	0.24	0.10	1.60
TOTAL	2.17	2.65	58.59	5.92	13.66	25.61	15.73	124.33
CHEMICAL CONSUMPTION:								
Chemicals (tons/yr)								
Cl_2	35	60	1900	145	210	105	60	2515
SO_2[a]	10	20	570	45	65	30	20	760
CaO	-	-	2280	-	405	1205	690	4580
$FeCl_3$	-	-	425	-	75	-	-	500
Alum	-	-	-	-	-	415	240	655
Polymer	-	3.8	-	5	-	20	15	43.8
CH_3OH	-	-	-	-	-	735	420	1155
NaCl	-	-	-	-	-	7300	4190	11,490
Activated Carbon	-	-	-	-	-	120	70	190

(a) SO_2 may be used for a mitigation measure if dechlorination is required by EPA standards.

Kenmore connection, the Kenmore outfall, the Val Vue connection, and a regulator at Third Avenue West.

Expansion at West Point and Alki would occur within 200 feet of the shoreline and would, therefore, require a permit from the Shorelines Management Master Program for Seattle. Richmond Beach expansion would necessitate a similar permit from King County. The whole Sammamish Valley, in which the North Lake Sammamish and South Lake Sammamish facilities would be installed, has been designed as a ten-year-flood plain zone. Therefore, construction of these facilities would necessitate a permit from the agency which regulates the State Flood Zone Act. Further, compliance with the regulations of the National Flood Control Act of 1968 would be required if federal grant money is to be obtained (National Flood Control Act, 1968).

Legal and institutional. Alternative H would fulfill the requirements of PL 92-500 and Washington NPDES regulations that secondary treatment be established. Other consequences of complying with PL 92-500, including timing considerations, would be the same as for Alternative E. Permits from the Shorelines Management Master Program for Seattle would have to be obtained at any location within the Seattle city limits where construction occurs within 200 feet of shoreline as explained under land use considerations.

Since North and South Lake Sammamish facilities would have advanced wastewater treatment, the effluent from these facilities would come closer to meeting the goal of PL 92-500 that by 1985 there be zero pollution discharge to navigable waterways. This water would be of a better quality than would be necessary for agricultural irrigation, but still probably would not be clean enough for drinking.

Agency goals. Alternative H fulfills the King County comprehensive plans of "taking all possible steps to abate pollution" and "installing utility lines in advance of the time of development." It also fulfills in part the objectives mentioned in Goals of Seattle to "undertake all means reasonable and feasible to ensure water purity to meet health standards and protect the environment, . . . to meet the goals of PL 92-500, . . . and to ensure clean water to protect wildlife, vegetation, and recreation areas."

It is speculative whether Alternative H fulfills the goal of PSCOG that, "it is in the public interest to minimize the costs of future growth by encouraging new development within urbanized areas where investments in public services have already been made."

Employment. It has been estimated that the construction involved in this alternative would require the employment of approximately 550 workers for 5 years. Operation and maintenance would require 188 employees at the West Point, Alki, Carkeek Park, Richmond Beach, Kenmore, North Lake Sammamish and South Lake Sammamish plants.

Costs. For Alternative H, the estimated capital cost for constructing new treatment facilities, collection systems, effluent disposal sites, sludge handling and disposal facilities (excluding Renton) would be $307,700,000 (1976 dollars), as summarized in Table 3-13 (Metropolitan Engineers, 1977). This is 0.32 percent of the $95.902 billion estimated by the EPA for implementation of PL 92-500 throughout the country (EPA, 1976). The estimated operation and maintenance costs (exluding Renton) would be $12,720,000 per year, as shown in Table 3-13 (Metropolitan Engineers, 1977).

The estimated average Metro monthly user charge per equivalent connection for the next 20 years would be $7.85 per month if all future facilities to 2005 are grant eligible, as shown in Table 3-14. User charges would be $9.70 per month if future capacity beyond 1985 is not grant eligible and would be $15.20 per month if no future facilities are grant eligible. Since Alternative H complies with the secondary treatment requirement of PL 92-500, which is a condition for grant funding, it appears that the probable user charge would be either $7.85 or $9.70 per month, an amount $0.55 below or $1.30 above the average expected user charge in Alternative B. Impact of cost would be adverse, moderate, long-term, irreversible and definite.

Social, recreational and cultural. Alternative H would meet the goal of 54 to 64 percent of the citizens surveyed (HRPI, 1976), who expressed a preference for secondary treatment. Impacts would be as described under Alternative E.

This alternative also has potential for reclamation and re-use of effluent and sludge, as well as potential for more complete local control of growth, but neither potential is completely developed in this alternative.

Opinions of the residents in the areas of the wastewater facilities are developed in the site specific documents.

Since only the Montlake and Third Avenue West regulator stations would be installed for control of combined sewer overflows, there still may be coliform levels occasionally exceeding health standards at swimming beaches along Lake Washington. This is considered adverse, major, highly limited in extent, long-term, reversible, and possible.

Archeological and historical. It has been determined that any archeological sites which may have occurred at West Point, Carkeek Park, Richmond Beach and Alki, would have already been destroyed by former construction; therefore, any more construction in these locations could not destroy archeological sites (Jerry Jermann, 1976). Data of archeological sites at North and South Lake Sammamish and Kenmore have not been determined. For historical sites, listed in Appendix E, none are known to be present at proposed construction sites.

Health and safety. A continued negative impact as in Alternative B would be associated with fecal coliform violations at Lake Washington public beaches.

Another highly unlikely safety hazard is accidental leakage of spills of chemicals when they are in transport or handled on site. Although nearly every U.S. water and wastewater treatment facility uses chemicals, there have been very few chemical-related accidents.

The health and safety problems related to sludge transport and disposal would be as improbable as for any other trucks in transit.

Construction risks to safety would be the same as for other construction of a similar nature; they would be adverse, minor, last only for the duration of construction, may be reversible, and are unlikely.

Aesthetics and nuisance. Introducing secondary treatment at West Point, Alki, Carkeek Park, and Richmond Beach would generate some site-specific nuisance impacts for local residents, as discussed in more detail in Volume II of the EIS for various sites. However, surveys and public workshops have generally indicated that more people (60 percent) in the vicinity of these facilities thought "cleaning up the environment" was more important than such aesthetic issues as hiding the facility (6 percent) (HRPI, 1976). These aesthetic and nuisance impacts are rated as adverse, minor, long-term, reversible, and probable.

Interceptor and regulator construction would be a short-term, reversible, local, and probable nuisance. Since the Kenmore tunnel would be about 100 feet underground, blasting often associated with tunneling would not disturb local residents along most of the tunnel route through this population district.

The nuisance or aesthetic factors associated with the installation of North and South Lake Sammamish and Kenmore treatment facilities have not been determined. Further environmental analysis will be undertaken for site-specific impacts if this more conceptual alternative is chosen.

Secondary Impacts

The secondary or indirect impacts of the alternative would result from expanding the Renton treatment plant and population growth. The effects of these changes on water quality, biology, energy, natural resources and the human environment are described below.

Water Quality

Impacts on the Duwamish estuary and groundwater are described below.

Duwamish estuary. At an average design capacity of 72 mgd, the Renton discharge would equal about 50 percent of the Duwamish summer low flows. The resulting flow augmentation could help alleviate temperature problems which develop in summer, but probably would not improve oxygen levels. Nutrient levels could be significantly affected by the increases in Renton effluent. Metals and toxicants input from Renton is expected to be minor. The overall adverse impact of expanding Renton is judged to be significant, because of the size of the discharge relative to the Duwamish flow and extensive because pollutants from the Duwamish can affect beaches over a wide area. Effects would be long-term because the increased discharge would continue through the planning period. Except for the accumulation of toxicants and heavy metals, impacts would be reversible. CSO's would add 1 percent of Renton's projected flow at 13 points.

Groundwater and other freshwaters. The impacts of (1) unsewered population growth on groundwater resources and (2) additional urban development on urban runoff and Lake Sammamish water quality would approximately be as described under Alternative B. With Alternative H, the potential exists for closer control of population distribution within inland areas served by the Kenmore, North Lake Sammamish and South Lake Sammamish plants, but the population number and distribution used in the Facility Plan for this alternative was the same as for all other alternatives.

Biology

In Alternative H, the Renton facility would be expanded to 72 mgd average flow, which would be 16 percent less than in Alternative B. The difference is important as the Renton flow to the Duwamish is large relative to the river's flow. Flow would affect the temperature and dissolved oxygen levels of the Duwamish, since the effluent would comprise almost half the river's summer low flow.

The increased freshwater flow would change the salinity distribution, such that summer blooms may consist of freshwater rather than marine phytoplankton. The flow could also provide better flushing of the estuary. The zooplankton would probably also change, but to a lesser degree. The benthos would continue to be stressed by CSO's, low DO and nutrient enriched sediments, although more flow could mean better dilution in summer. The net effect on the benthos of the various minor benefits and major negative impacts is moderate-to-major, negative and extensive. The effect on migratory fishes would also be moderate-to-major, adverse, extensive, and of long duration due to increased levels of nitrates and low DO, discussed previously. The effect on other fishes could also be major and adverse. Waterfowl could leave if their prey species are adversely impacted. The effects are considered to be reversible.

Energy and Natural Resources

Energy. For Alternative H, a net of 46 million equivalent kwh/year of energy would be consumed in 2005 at Renton. Included would be 40 million kwh/year of electrical energy purchased; 1 kwh/year equivalent energy for sludge trucking and 9 million equivalent kwh/year required to produce the chemicals consumed. A net of 4 equivalent kwh/year would be produced by the process of anaerobic digestion. The impact of the energy consumption would be adverse, moderate in magnitude, long-term, irreversible and definite.

Chemicals. Chlorine, sulfur dioxide, lime, and polymer would be used with annual consumption rates of 850, 255, 6650, and 935 tons, respectively, at Renton. The impact of chemical usage would be adverse, moderate, long-term, irreversible and definite. The supplies of chlorine, sulfur dioxide, and polymer are reliable. Lime is available in moderate supply.

Human Environment

Impacts on population, employment, and costs are described in the following section.

Population and employment. The Deconsolidation/Reclamation Alternative could result in a slight facilitation of regional growth over the long term due to the improvement or preservation of water quality.

Alternative H may also encourage or limit growth in outlying areas near Lake Sammamish and Northern Lake Washington, because of the three wastewater treatment facilities which would be constructed in these areas. Impacts would be dependent upon response of local governmental officials.

Operation and management employment at Renton would be 58 people, plus other Metro related staff. Construction would involve approximately 150 employees for 5 years.

Costs. Capital costs for construction at Renton would be $94,300,000, as indicated in Table 3-13. Renton operation and maintenance would cost $4,380,000 per year. The effect of this on user charge is noted in the primary impact section, since user charges are determined on a Metro-wide basis. Impact of cost would be adverse, moderate, long-term, irreversible, and definite.

Mitigation Measures

Several mitigation measures are suggested to aid in the reduction of adverse impacts resulting from the implementation of this alternative.

An improved chlorine feed system can be designed to prevent chlorine levels in the Alki, Carkeek Park and Richmond Beach sewage treatment plant effluent water from exceeding dangerous levels. This could be achieved by matching chlorine levels to effluent discharge, and/or installing a chlorine contact tank, which would maximize the effectiveness of chlorination treatment. Currently chlorine is injected into the effluent flow at a constant rate set daily, regardless of hourly fluctuations in wastewater flow through the treatment facility. This causes a fluctuating chlorine residual. Chlorine feed rate is residual paced at West Point but peaks in residual chlorine are not uncommon. In addition, the residual is measured a short distance downstream of the chlorine feeding point and therefore does not reflect the actual chlorine residual before discharging to Puget Sound. Control of chlorine residual would be achieved at West Point through installation of a chlorine contact tank.

Pretreatment of industrial wastes could be provided before sewage enters the West Point plant. If current practices continue, influent to these facilities would occasionally contain slugs of cadmium, mercury and arsenic.

Visual nuisance of the wastewater treatment facilities can be mitigated by (1) designing new facilities and additions to existing facilities utilizing natural geographic features (e.g., bluffs) and (2) landscaping the facilities.

Odor of the wastewater treatment facilities can be mitigated, in part, by not allowing the system to become anaerobic. Under anaerobic conditions, noxious gases such as methane and sulfur dioxide are emitted. Odor control measures independent of facility planning decisions are currently being evaluated by Metro.

The energy impact can be in part defrayed by utilizing more of the methane gas which is produced by anaerobic digestion. Nearly half of this methane gas is flared off under current practices. However, the cost-effectiveness of methane storage and transport has not been determined yet.

The high coliform levels at public beaches could possibly be reduced by using the CATAD computer control system to plan the discharge of combined sewer overflows at sites remote from the public beaches as a first preference.

Unavoidable Adverse Impacts

Under Alternative H, the following adverse impacts would be unavoidable:

- Construction impacts
- Sludge trucking
- Combined sewer overflows
- Land use changes
- Aesthetic nuisance of plant location
- Operation and maintenance (O&M) and capital costs
- Energy expenditures

For greater detail regarding unavoidable impacts, the reader is referred to the preceding impact analysis.

IMPACTS OF GROWTH

The direct and indirect impacts of population increase and distribution have been considered in the EIS to the extent feasible. The background on population projections for future alternatives plus descriptions of agencies that can influence growth patterns and a summary of primary and secondary impacts are presented in this section.

Population Projections

Since the EIS analyzes impacts from the Draft Facility Plan (Metropolitan Engineers, 1977), the population projections developed in the facilities planning process have been used in the EIS. The regional population for the Metro study area (including Renton) in 2005 was based on the Puget Sound Council of Governments intermediate 201/208 forecasts as described in Chapter II. The 2005 population was projected to be 1,502,000 representing a 45 percent increase over the 1975 population of 1,034,000. For the existing or designated service areas for the Puget Sound plants (West Point, Alki, Carkeek Park and Richmond Beach), the 1975 population of 699,000 would increase by 34 percent to 943,000.

Under Alternatives A through H, the 2005 population and its distribution would be the same, regardless of wastewater facilities, according to the assumptions in the Draft Facility Plan. The only differences are (1) the number of sewered and unsewered persons and (2) the number of persons within the area served by various wastewater treatment plants. Under Alternative A, the total Metro service area population would include 900,000 sewered and 602,000 unsewered persons, for the total regional population of 1,502,000. Under the remaining alternatives, the sewered population would be 1,478,000, only 24,000 of the 1,502,000 population would not be sewered. The population distribution, however, would be identical under all regional alternatives. Variations in collection systems and major transfer interceptors would determine the flow to any given wastewater treatment plant, but the total sewered wastewater flow would be a constant under Alternatives B through H.

Agency Policies and Growth Patterns

Several governmental units or agencies have some influence on population and distribution patterns within the Metro service area. Among these are local, regional and state agencies.

Metro constructs and operates regional wastewater facilities and reviews local plans. The agency is presently preparing a 208 plan that considers on-site individual wastewater treatment units and other alternatives to sewers. Although Metro may have some indirect influence on the location of interceptor sewers to serve areas projected for growth, Metro's official policy on interceptors is that it will not participate in the planning, design or construction of any interceptors without formal legislative action in writing from the municipality or county having jurisdiction for land use planning in that area. The exception is under legal, regulatory or public health requirements (R. Page letter to Metro Council, March 23, 1977). Procedures for implementing this policy are described in Metro's Draft 208 Plan.

In the Draft Facility Plan, there are no proposed interceptors that would serve new growth areas. For example, under Alternative A where no new facilities would be constructed, the sewered population in the service areas for West Point, Alki, Carkeek Park and Richmond Beach would increase from 594,000 (in 1975) to 620,000 (in 2005) due to filling in of undeveloped areas presently served by sewers. However, the remaining 323,000 persons in the combined service area would not be served by the wastewater collection system. For Alternatives B through H, the proposed interceptors would be collection system transfer interceptors needed to accommodate the proposed changes in wastewater treatment plant service areas (Figure 3-1), rather than to serve areas of projected population increase. Most interceptors to serve new growth would be built within the present Renton service area which is not included as part of the Draft Facility Plan and the Draft EIS. Individual interceptors for newly developing areas would be governed in the future by the Metro policy described previously.

The direct or indirect influences of other agencies on relationships among sewers, land use and population are summarized below.

Incorporated cities and towns have the authority to control or regulate local sewer collection systems, septic tanks and land use patterns, thus influencing growth patterns as well as some water quality impacts. King County has these same functions for unincorporated areas, plus the responsibility to review sewerage plans, issue franchises to water and sewer districts, and determine property tax assessments. Sewer districts and some water districts can prepare comprehensive sewerage plans, construct and operate local sewer collection systems. The Seattle/King County Health Department regulates septic tanks and can establish a building moratorium if adverse health effects result. The State Department of Social and Health Services sets minimum standards for septic tanks and is also investigating on-site treatment. The Boundary Review Board reviews and approves governmental boundary changes. The Puget Sound Council of Governments (PSCOG) prepares regional population and land use forecasts, which are used by local agencies for planning, and reviews interagency proposals that would require federal funding. The DOE determines wastewater facilities priorities, funds 15 percent of eligible capital costs, sets state water quality standards and regulates permitted discharge. The EPA funds up to 75 percent of the capital costs of eligible wastewater facilities.

Primary Impacts from Growth

The impacts that can be directly attributed to additional population in the study area have been addressed in the Draft EIS. The main impacts are related to increasing wastewater flow and facilities costs.

One direct impact from population growth projected in the Draft Facility Plan would be production of larger amounts of wastewater, which could affect combined sewer overflows or wastewater treatment plant discharges. Impacts of combined sewer overflows on water quality, biology and public health are described for each alternative in the Draft EIS. These impacts would occur to some degree under Alternatives A through H. The locations and volumes of CSO's and treatment plant discharges would depend upon service area selection, treatment plant discharge site and CSO controls and would thus differ with Alternatives A through H even though population distribution would remain the same.

Larger populations and wastewater flows would also affect costs, since costs for wastewater transport, transfer, treatment and disposal are related to facilities site. These costs impacts are described for each alternative under the human environment section.

Alternatives and Impacts

Secondary Impacts of Growth

The secondary impacts of growth are described briefly below because growth has been an important issue in comments on the EIS received to date and because growth is implicit in the Facility Plan as regards facilities siting even though growth interceptors are not explicitly proposed by Metro.

Several points on regional population totals are relevant before discussing secondary impacts.

First, the additional 468,000 total Metro service area population projected to 2005 is roughly equivalent to the current population of Seattle (500,000) which illustrates the overall magnitude of growth.

Second, more undeveloped land is available than needed for future growth in the Metro service area (PSCOG, 1976).

Third, while interceptors are not the sole causative factor in population distribution, it was formerly believed that many areas in the Metro service area could not develop beyond a low density without interceptors due to soil and geologic constraints affecting feasibility of individual treatment/disposal units (Wells, 1976). However, more recent King County and PSCOG comments are that most areas in the Metro service area can develop beyond a low density without interceptors. Local agencies and the Metro 208 Plan will examine alternatives for treating wastes that may allow higher densities than septic tanks. However, where interceptors are built to serve less developed areas, they could continue to affect the location of sewered population.

Fourth, long-range population projections are subject to revisions and modifications based on future events that are not entirely within the control of planning agencies or contained within the original assumptions on population change.

Fifth, the effect of interceptor service on future growth would be more pronounced in the northern and eastern portions of the Metro service area rather than in the other presently developed areas.

Some of the secondary impacts of projected growth patterns relative to present population would be:

1. Conversion of more undeveloped land to impervious surface (assuming the same ground levels) would result in an increase in runoff and water quality

problems from urban drainages, particularly for Lakes Sammamish and Washington.

2. Increase in population and extent of developed area could generate more air pollutants, depending on future control technology.

3. Pumping larger quantities of sewage in the expanded collection system would require more energy.

4. The larger population would place additional demands on energy and natural resources, unless effective construction measures were instituted.

5. In areas where development proceeded without sewers, impacts would depend on treatment technology. Septic tanks could result in groundwater and surface water degradation; septic tank failures, likely because of relatively impervious soils and uncertain maintenance, could have adverse health effects. Impacts from alternative technologies are being studied in the 208 Plan.

6. Increases in developed land would interfere with existing vegetation and wildlife habitat areas.

7. Additional growth, beyond that projected in the Facility Plan, could be accommodated in some service areas where combined sewer overflow control is presently proposed if, in the future, sewer separation occurred and the dry weather plant capacity more closely approached its wet weather capacity.

8. Equity among existing and new Metro customers may be an issue since new facilities will be paid for by all customers equally, under the current rate structure. The question of equal distribution of benefits has also been raised; protecting water quality in regional resources such as Puget Sound supports arguments in favor of equal benefits received.

SUMMARY

Impacts of the regional alternatives are compared in terms of geology, soils and topography; air quality and odors; water quality; biology; natural resources and energy; and the human environment.

Geology, Soils and Topography

The eight alternatives were evaluated for regional impacts with respect to the following categories: slope and foundation stability, earthquake hazard risk, erosion and deposition, topography and soil profiles, shoreline fill and marine sediments, sludge disposal sites and construction waste disposal sites.

No alternative would affect topography and soil profile other than by minor changes at treatment plant sites.

Construction of transfer interceptors, treatment plants and/or combined sewer overflow control facilities under alternatives other than Alternative A would have temporary effects on topography, erosion and deposition. In particular, constructing the various combined sewer overflow control facilities under Alternatives C and D would be temporarily disruptive. Impacts would be reversible in many instances following completion of construction.

Consequently the Kenmore parallel interceptor under Alternatives B, E, and G could cause some erosion, deposition and siltation along the northwest shore of Lake Washington. However, most impacts are controllable by following proper construction priorities or by selecting an optional inland route for the interceptor.

Shoreline fill required by West Point treatment plant upgrading to secondary treatment under Alternatives E and H would cause changes in topography, which are described in the West Point EIS (Volume II).

Construction activities at new treatment plant sites would involve site preparation and grading under Alternative C (Duwamish plant at Diagonal Way), Alternative F (Duwamish plant at Harbor Avenue, S.W.), Alternative G (in the Interbay area Golf Park site), and Alternative H (Kenmore, North Lake Sammamish and South Lake Sammamish).

Earthquake risk would be a function of structure and site. Fill or soft, loosely consolidated soils would present the highest seismic risk, which should be considered in facility design to minimize risk of earthquake damage.

Construction waste disposal sites would be required for most alternatives, but since sites have not been selected, impacts cannot be projected.

Impacts of sludge disposal practices would be monitored for all alternatives at the Cedar Hills landfill and Park Forest site. Although alternatives that include secondary treatment (Alternatives E, F, G and H) would generate more sludge than other alternatives, the additional sludge would only reduce the projected 30-year Cedar Hills landfill life by 1 year, even if all sludge were disposed of there.

Impacts on geology, soils and topography for regional alternatives are summarized in Table 3-38. Impacts would result from all alternatives, including Alternative A (No Action) which would continue sludge disposal on land and earthquake risk to existing structures. Alternative B would produce more impacts than Alternative A due to construction of transfer interceptors and disposal of construction wastes. For the remaining Alternatives C through H, there would be major construction activities that could affect geology, topography and soils. Although the alternatives contain different mixtures of projects (treatment plants, transfer interceptors, combined sewer overflow control structures, outfalls and others), the overall impacts of Alternatives C through H would be similar in magnitude. Therefore, it is concluded that the physical impacts on land resources, although possibly moderate-to-major in magnitude, do not serve to distinguish among Alternatives C through H in the decision-making process. Each of these alternatives would produce impacts, but the decision would be based on which areas are of greatest importance.

Air Quality and Odors

Impacts on regional air quality from all alternatives would be negligible. Some odors would be generated in localized areas near wastewater treatment plants and combined sewer overflow points.

Projections of air pollutant emissions in 2005 were estimated for all Metro wastewater treatment facilities according to the procedures described in Appendix C. Estimated daily emissions of hydrocarbons, carbon monoxide and

TABLE 3-38

IMPACTS ON GEOLOGY, SOILS AND TOPOGRAPHY

IMPACTS FROM PROJECTS	REGIONAL ALTERNATIVES							
	A	B	C	D	E	F	G	H
Grading for construction at new plant sites			X			X	X	X
Grading for construction at existing plant sites					X	X	X	X
Foundations for equipment at existing sites		X	X	X				
Earthquake risk to structures	X	X	X	X	X	X	X	X
Shoreline fill for plant expansion					x			x
Excavation or tunneling from transfer interceptor construction		X	X	X	X	X	X	X
Erosion, deposition, siltation in freshwater		X			X		X	
Disturbance of benthic sediment in enclosed bay or canal					X	X	X	
Benthic disturbance from new outfall construction			X	X		X	X	X
Excavation for combined sewer overflow control structures			X	X				
Disposal of construction wastes		X	X	X	X	X	X	X
Disposal of sludge at landfill or forest site	X	X	X	X	X	X	X	X

nitrogen oxides for sludge trucking and treatment plant personnel traffic are summarized in Table 3-39. For all alternatives, emissions from employee traffic greatly exceed emissions from sludge truck traffic, primarily due to the differences in vehicle miles traveled. As plant size, number and treatment process complexity increase, the number of employees increases; therefore, air pollutant emissions for secondary treatment alternatives (E, F, G and H) are higher than for primary or enhanced primary alternatives (A, B, C and D). The alternatives show little difference in sludge truck emissions, since alternatives that contain treatment processes which produce larger sludge volumes also include more on-site sludge processing facilities. Although calculations for Table 3-39 assumed all sludge would be transported to Cedar Hills landfill, the fact that some sludge (approximately 40 percent) would be transported to Pack Forest would not significantly affect air pollutants because sludge truck traffic contributes a small share of the air pollutants compared to plant personnel traffic. Since activities under all alternatives would emit less than 1 percent of the total air pollutants produced in the Seattle area at present, Alternatives A through H would have a negligible impact on air quality of the area in 2005.

Odors are described in detail in site-specific documents but are summarized here. At Alki, odors would continue under Alternatives A, B and D and would probably increase under Alternatives E, G and H as secondary treatment is provided, unless Metro implements separate odor control measures that are now being considered independent of other facilities planning decisions. With abandonment in 1995 (Alternative F), plant odors at Alki would be eliminated. Until the time of abandonment, odors would continue unless controlled. At Carkeek Park, odor could be detected in the park near the plant under Alternatives A, B, C and D; it could increase slightly under Alternative H (secondary treatment). With conversion to wet weather treatment under Alternatives E, F and G, Carkeek Park plant odors would be eliminated in dry weather. Odors, which have not been a problem at Richmond Beach to date, would increase under secondary treatment (Alternatives E, F, G and H), but would not be a concern beyond the plant boundary. At West Point, odors at the plant site would continue under Alternatives A, B, C and D; they could increase under secondary treatment (Alternatives E, F and H) and would be eliminated in dry weather under Alternative G. In any case, odors at West Point would typically be unnoticeable beyond the plant property. Other areas would be affected by new wastewater treatment plants and attendant odors under Alternative C (Duwamish Diagonal Way site), Alternative F (Duwamish Harbor-Avenue, S.W. site), Alternative G (Interbay Golf Park site), and Alternative H

TABLE 3-39

AIR QUALITY IMPACTS SUMMARY

AIR POLLUTANTS FROM PROJECT ACTIVITIES (grams/day)	REGIONAL ALTERNATIVES							
	A	B	C	D	E	F	G	H
Hydrocarbons								
Sludge Trucking	435	710	440	435	415	425	440	520
Personnel	2455	3590	4790	4205	5190	5340	6080	6815
Total	2890	4300	5230	4640	5605	5765	6520	7335
Carbon Monoxide								
Sludge Trucking	2710	4435	2755	2710	2885	2645	2740	3230
Personnel	31250	45700	60935	53510	66010	67965	77340	86715
Total	33690	50135	63690	56220	68595	70610	80080	89945
Nitrogen Oxides								
Sludge Trucking	1975	3230	2010	1975	1880	1930	1995	2350
Personnel	4050	5920	7895	7895	8550	8805	10020	11235
Total	6025	9150	9905	8905	10430	10735	12015	13585

NOTE: Calculations assume all sludge would be trucked to Cedar Hills landfill.

(Kenmore, North Lake Sammamish and South Lake Sammamish plant sites). On a regional level, some odors would continue at combined sewer overflow locations under each alternative. On a regional level, none of the alternatives would have major adverse impacts. Site-specific EIS volumes should be consulted for more detail on localized odors and their impacts.

Water Quality

The impacts of regional alternatives on water quality represent a key issue in both the facilities planning and EIS process. Central to the EIS analysis were the types of wastewater treatment and combined sewer overflow controls for each alternative. Important elements of consideration for treatment plant discharges were (1) treatment process, (2) effluent quality, (3) wastewater flows under average and peak conditions, (4) effluent discharge location, (5) receiving water characteristics and (6) dilution or dispersal conditions. For combined sewer overflows, evaluations included (1) overflow location, (2) overflow frequency, (3) overflow quality (based on the limited data available), (4) receiving water characteristics, and (5) dilution or dispersal conditions.

The projected wastewater flows and pollutant loads to receiving waters are summarized for regional alternatives (in 2005) and existing conditions (in 1975) in Table 3-40. Projections of wastewater volume, solids load and biochemical oxygen load (BOD) on an annual basis were provided by the facilities planning engineers and represent updated information from the Draft Facility Plan.

The table summarizes combined sewer overflows to Lake Washington, Lake Sammamish, Portage Bay/Montlake Cut, Lake Union, Ship Canal/Salmon Bay, Elliott Bay, Alki Beach, and the Duwamish/Green River from the Metro/Seattle overflow points for each alternative. CSO volumes were estimated from a computer model by the facilities planning engineers. Average pollutant loads in combined sewer overflows, based on calculations from information in Table 3-40, would be 218 milligrams per liter (mg/l) suspended solids and 60 mgl BOD. Only limited sampling has been made on other water quality components in combined sewer overflows.

Discharges from wastewater treatment plants are also summarized in each alternative in Table 3-40. Depending upon which alternative is selected, total Metro treatment plant discharge volumes in 2005 would exceed combined sewer

TABLE 3-40

SUMMARY OF
WASTEWATER FLOWS AND POLLUTAN
TO RECEIVING WATERS IN 20

Note: Regional alternatives are compared to Alternative B

	EXISTING CONDITIONS (1975)			ALTERNATIVE A			ALTERNATIVE B			ALTERNATIVE C			ALTE
	Volume (mgy)	Solids (tons/yr)	BOD (tons/yr)	Volume (mgy)	Solids (tons/yr)	BOD (tons/yr)	Volume (mgy)	Solids (tons/yr)	BOD (tons/yr)	Volume (mgy)	Solids (tons/yr)	BOD (tons/yr)	Volume (mgy)
Lake Washington	16.4 -27%	14.9 -27%	4.1 -27%	16.4 -27%	14.9 -27%	4.1 -27%	22.4	20.4	5.6	.19 -99%	.17 -99%	.05 -99%	3.76 -83%
Lake Sammamish	0 X	0 X	0 X	0 X	0 X	0 X	0	0	0	0 X	0 X	0 X	0 X
Portage Bay/Montlake Cut	194.6 -15%	177 -27%	48.5 -18%	194.6 -15%	177 -27%	48.5 -18%	228	241	59.3	35.8 -84%	32.4 -87%	8.91 -85%	147 -36%
Lake Union	41.5 -27%	37.6 -27%	10.3 -27%	41.5 -27%	37.6 -27%	10.3 -27%	56.6	51.4	14.1	4.14 -93%	3.76 -93%	1.03 -93%	22.2 -61%
Ship Canal/Salmon Bay	186 -27%	169 -27%	46.4 -27%	186 -27%	169 -27%	46.4 -27%	254	231	63.3	28.0 -89%	25.4 -89%	6.97 -89%	128 -50%
Elliott Bay	358 0%	325 0%	89 0%	358 0%	325 0%	89 0%	358	325	89	448 +25%	406 +25%	112 +26%	433 +21%
Alki Beach	5.5 0%	5.0 0%	1.36 0%	5.5 0%	5.0 0%	1.36 0%	5.5	5.0	1.36	.15 -97%	.14 -97%	.04 -97%	4.47 -18%
Duwamish/Green River	251 0%	227 0%	62 0%	251 0%	227 0%	62 0%	251	227	62	186 -26%	168 -26%	46 -26%	251 0%
Subtotal - Combined Sewer Overflow	1,053 -10%	955.5 -13%	261.7 -11%	1,053 -10%	955.5 -13%	261.7 -11%	1,175.5	1,100.8	294.7	702.3 -40%	635.9 -42%	175 -41%	989.4 -16%
West Point Treatment Plant	43,100 -23%	10,800 -23%	14,400 -23%	43,100 -23%	10,800 -23%	14,400 -23%	56,200	14,000	18,800	57,500 +2%	11,200 -20%	15,100 -20%	54,000 -4%
Alki Treatment Plant	3,010 -18%	749 -18%	1,000 -18%	3,650 0%	910 0%	1,220 0%	3,650	913	1,220	0 -100%	0 -100%	0 -100%	3,650 0%
Carkeek Park	1,150 -25%	289 -24%	385 -25%	1,530 0%	380 0%	510 0%	1,530	380	510	1,530 0%	297 -22%	404 -21%	1,530 0%
Richmond Beach	600 -34%	150 -35%	200 -33%	912 0%	230 0%	300 0%	912	230	300	912 0%	177 -23%	241 -20%	912 0%
Renton	10,749 -66%	676 -66%	673 -66%	12,050 -62%	753 -62%	758 -62%	31,350	1,973	1,968	36,114 +15%	702 -64%	1,514 -23%	36,050 +15%
Subtotal - Treatment Plant Discharges	58,609 -37%	12,664 -28%	16,658 -27%	61,242 -35%	13,073 -25%	17,188 -25%	93,642	17,496	22,798	96,056 +3%	12,376 -29%	17,259 -24%	96,142 +3%
TOTAL	59,662 -37%	13,620 -27%	16,920 -27%	62,295 -34%	14,029 -25%	17,449 -24%	94,817	18,597	23,092	96,758 +2%	13,012 -30%	17,434 -25%	97,131 +2%

[a] North Lake Sammamish and South Lake Sammamish treatment plant discharge

[b] Subtotal - Combined Sewer Overflow does not include volumes, solids or BOD loads for Lake Sammamish.

[c] TOTAL includes volume, solids and BOD loads for Lake Sammamish.

[d] Discharge from Duwamish plus Renton plants off Alki Point.

[e] Discharge from Interbay plus West Point.

[f] Includes Kenmore discharge.

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TABLE 3-40

SUMMARY OF
ER FLOWS AND POLLUTANT LOADS
ECEIVING WATERS IN 2005

ALTERNATIVE C			ALTERNATIVE D			ALTERNATIVE E			ALTERNATIVE F			ALTERNATIVE G			ALTERNATIVE H		
Volume (mgy)	Solids (tons/yr)	BOD (tons/yr)	Volume (mgy)	Solids (tons/yr)	BOD (tons/yr)	Volume (mgy)	Solids (tons/yr)	BOD (tons/yr)	Volume (mgd)	Solids (tons/yr)	BOD (tons/yr)	Volume (mgd)	Solids (tons/yr)	BOD (tons/yr)	Volume (mgd)	Solids (tons/yr)	BOD (tons/yr)
.19 -99%	.17 -99%	.05 -99%	3.76 -83%	3.41 -83%	0.94 -83%	23.0 +3%	20.9 +3%	5.72 +3%	15.4 -31%	14.0 -31%	3.83 -31%	23.0 +3%	20.9 +3%	5.72 +3%	19.1 -15%	17.4 -15%	4.76 -15%
0 X	0 X	0 X	0 X	0 X	0 X	0 X	0 X	0 X	0 X	0 X	0 X	0 X	0 X	0 X	5,110[a] X	213[a] X	213[a] X
35.8 -84%	32.4 -87%	8.91 -85%	147 -36%	133 -45%	36.5 -38%	232 +2%	247 +3%	60.8 +3%	188.8 -17%	166 -31%	40.7 -31%	232 +2%	247 +3%	60.8 +3%	210 -8%	205 -15%	50.2 -15%
4.14 -93%	3.76 -93%	1.03 -93%	22.2 -61%	20.1 -61%	5.52 -61%	58.1 +3%	52.7 +3%	14.4 +2%	38.9 -31%	35.3 -31%	9.68 -31%	58.1 +3%	52.7 +3%	14.4 +2%	48.3 -15%	43.8 -15%	12.0 -15%
28.0 -89%	25.4 -89%	6.97 -89%	128 -50%	116 -50%	31.8 -50%	261 +3%	236 +2%	64.9 +3%	175 -31%	158 -32%	43.5 -31%	261 +3%	236 +2%	64.9 +3%	217 -15%	197 -15%	54.0 -15%
448 +25%	406 +25%	112 +26%	433 +21%	392 +21%	108 +21%	358 0%	325 0%	89 0%	304 -15%	275 -15%	76 -15%	358 0%	325 0%	89 0%	358 0%	325 0%	89 0%
.15 -97%	.14 -97%	.04 -97%	4.47 -18%	4.06 -18%	1.11 -18%	5.46 0%	4.95 0%	1.36 0%	0.15 -97%	0.14 -97%	0.04 -97%	5.46 0%	4.95 0%	1.36 0%	5.46 0%	4.95 0%	1.36 0%
186 -26%	168 -26%	46 -26%	251 0%	227 0%	62 0%	251 0%	227 0%	62 0%	251 0%	227 0%	62 0%	251 0%	227 0%	62 0%	251 0%	227 0%	62 0%
702.3 -40%	635.9 -42%	175 -41%	989.4 -16%	895.6 -19%	245.9 -17%	1,188.6 +1%	1,113.6 +1%	298.2 +1%	973.3 -17%	875.4 -21%	235.8 -20%	1,188.6 +1%	1,113.6 +1%	298.2 +1%	1,108.9[b] -6%	1,020.2[b] -7%	273.3[b] -7%
57,500 +2%	11,200 -20%	15,100 -20%	54,000 -4%	10,500 -25%	14,300 -24%	57,900 +3%	3,600 -74%	3,600 -81%	40,200 -29%	2,510 -82%	2,510 -87%	57,700[e] +3%	3,890[e] -72%	3,710[e] -80%	47,800 -15%	2,990 -79%	2,990 -84%
0 -100%	0 -100%	0 -100%	3,650 0%	710 -22%	964 -21%	3,650 0%	228 -75%	228 -81%	54,300[d] +1,383%	3,400[d] +272%	3,400[d] +179%	3,650 0%	228 -75%	228 -81%	3,650 0%	228 -75%	228 -81%
1,530 0%	297 -22%	404 -21%	1,530 0%	297 -22%	404 -21%	0 -100%	0 -100%	0 -100%	0 -100%	0 -100%	0 -100%	0 -100%	0 -100%	0 -100%	1,530 0%	957 +152%	957 +88%
912 0%	177 -23%	241 -20%	912 0%	177 -23%	241 -20%	912 0%	57.1 -75%	57.1 -81%	912 0%	57.1 -75%	57.1 -81%	912 0%	57.1 -75%	57.1 -81%	8,580[f] +841%	537[f] +134%	537[f] +79%
36,114 +15%	702 -64%	1,514 -23%	36,050 +15%	753 -62%	1,508 -23%	31,350 0%	663 -66%	1,308 -34%	0 -100%	0 -100%	0 -100%	31,350 0%	663 -66%	1,308 -34%	26,250 -16%	553 -72%	1,098 -44%
96,056 +3%	12,376 -29%	17,259 -24%	96,142 +3%	12,437 -29%	17,417 -24%	93,812 0%	4,548 -74%	5,193 -77%	95,412 +2%	5,967 -66%	5,967 -74%	93,612 0%	4,838 -72%	5,303 -77%	87,810 -6%	5,265 -70%	5,810 -75%
96,758 +2%	13,012 -30%	17,434 -25%	97,131 +2%	13,333 -28%	17,663 -24%	95,000 0%	5,662 -70%	5,492 -76%	96,385 +2%	6,842 -63%	6,203 -73%	94,800 0%	5,952 -68%	5,602 -76%	94,028[c] +1%	6,498[c] -65%	6,296[c] -73%

B

overflow volumes by 59 to 137 times. Thus, effects of plant discharge were examined systematically in the EIS. Based on information in Table 3-40, updated from the Draft Facility Plan by the facilities planning engineers, the annual average treated water quality (suspended solids/BOD in mg/l) would be as follows: primary (60/80), enhanced primary (46/63), secondary (15/15), secondary plus nitrification and filtration (5/10), and advanced waste treatment (10/10).

Based on the information in Table 3-40, regional impacts on water quality were projected. Since the regional alternatives essentially contain either treatment plant upgrading or combined sewer overflow control, the tradeoffs in water quality impacts are apparent.

For combined sewer overflows, Alternative C (Major CSO Control) would achieve the largest degree of control relative to Alternative B of 40 percent overall and over 80 percent to some receiving waters (Lake Washington, Portage Bay/Montlake Cut, Lake Union, Ship Canal/Salmon Bay, and Alki Beach). In comparison, Alternative D (Partial CSO Control) would reduce total CSO's by 16 percent compared to Alternative B. Alternative F (Secondary/Southern Strategy), the only alternative devloped with treatment plant upgrading and combined sewer overflow control objectives, would reduce total CSO's by a comparable amount (17 percent decrease relative to Alternative B), but Alternative F would emphasize CSO control to saltwater (Elliott Bay, Alki Beach) rather than freshwater (Lake Washington). Alternative H would achieve a minor (6 percent) CSO reduction due to transfers in service area. Alternatives E and G would increase total CSO volume by a minor amount (1 percent). Alternative B would result in increased (12 percent) combined sewer overflows over existing conditions due to larger sewered populations. Alternative A would continue at existing overflow levels.

In order of increasing combined sewer overflow control, the regional alternatives would be ordered as follows: E and G, B, H, A, D, F and C. Since combined sewer overflows could adversely affect concentrations of nutrients, toxicants and microorganisms in localized portions of receiving waters near the overflow points, controlling CSO's could have beneficial impacts on water quality. However, none of the proposed alternatives would achieve complete CSO control.

The discharge of treated wastewater would also affect water quality, primarily to a limited degree and localized near outfalls. With the exception of Alternative H, all Metro treatment plants included in the Draft Facility Plan would discharge wastewater to Puget Sound. Therefore, impacts on the sound are central in describing water quality impacts.

The total wastewater discharge to Puget Sound (including Elliott Bay) in 2005 would be approximately 49 billion gallons under Alternative A (approximately 1 billion gallons per year more than existing flow). Annual flows in gallons for other alternatives would increase due to increases in sewered population and selection of service area in the following order: Alternatives C and D (60 billion), Alternatives B, E and G (62 billion), Alternative H (69 billion) and Alternative F (95 billion). The discharge for Alternative F is larger than others due to the transfer of flows from the inland plant at Reaton to the Alki outfall.

In terms of water quality impacts, the alternatives can be compared in terms of pollutant loads which are more meaningful than total flows. As an indication of possible contamination, the suspended soilds loads to Puget Sound have been estimated. (Suspended solids were selected since they can absorb metals, organics of other toxicants that could affect marine life and they could protect microorganisms from disinfectant action). For increasing potential impacts on water quality related to suspended solids, the alternatives would be ordered as follows: Alternatives E and G (4 tons/yr); Alternative H (5 tons/yr); Alternative F (6 tons/yr); Alternatives A, C and D (12 tons/yr); and Alternative B (16 tons/yr).

The total solids loads indicate the secondary treatment alternatives (E, F, G and H) would be less likely to affect Puget Sound water quality than primary treatment (Alternatives A and B) or enhanced primary treatment (Alternatives C and D). Alternatives A, C and D would discharge approximately the same solids load to the sound at existing plants. Therefore, these alternatives would represent nondegradation (but also no improvement) over existing conditions which have been shown to produce minor changes in water quality (higher turbidity, lower dissolved oxygen) near the outfalls studied. Alternative B, by serving larger populations and not upgrading treatment, would increase the potential for water quality changes. The secondary treatment alternatives (e, F, G and H) would decrease solids to 4-6 tons/yr and are expected to show some improvements in water quality.

One water quality parameter that would not be substantially improved, with upgraded treatment would be nitrogen. Therefore, all alternatives except A would result in additional nutrient discharge, which may affect the intensity of plankton blooms.

The location of discharge is also an important consideration, since potential impacts could be transferred from one area to another. Alternatives A, B and D would continue at West Point, Alki, Carkeek Park and Richmond Beach, while Alternative D would transfer flows from Alki and elsewhere to the Duwamish Plant for discharge to the Duwamish. Alternative E will continue existing discharge points except at Carkeek Park; Alternative G would be similar except for some added discharge to Elliott Bay. Alternative F would add flows from Renton off Alki Point, but eliminate discharges at Carkeek Park. Alternative H would increase discharge off Richmond Beach and produce wastewater inland for disposal to Lake Sammamish, the Sammamish River and/or land applications. Thus, the location of potential impacts in Puget Sound would be related to discharge point. For discharge at new locations or where flow would increase substantially (Alternative F at Alki, Alternative G at Elliott Bay, or Alternative H at Richmond Beach), further environmental analysis of more conceptual alternatives would be completed if such an alternative were selected.

Because of observed circulation patterns that produce some eddies at slack tide, it appears that diluted effluent could reach nearby beaches. Although not all the existing outfalls and beaches have been sampled for effluent dilution, it appears from other information on circulation diluted effluent could reach beaches near the plants. In terms of water quality, alternatives with upgraded treatment would be less likely to contain microorganisms, suspended solids, or toxicants that could produce minor adverse effects on nearshore water quality.

In conclusion, it appears that all regional alternatives could have some impact on water quality in Puget Sound. Upgraded treatment would reduce the potential for adverse impacts, but none would completely clean up Puget Sound. In addition to Metro's wastewater loads, Puget Sound would still be subject to combined sewer overflows, flows from other municipal discharges, industries, urban runoff, aerial fallout, and transportation.

Many unknowns remain in assessing Puget Sound water quality today or in the future. Evidence to date suggests that present Metro discharges have produced only minor changes (such as decreases in dissolved oxygen or increases in turbidity and nutrients) which have occurred only near the outfalls. However, not all sites have been sampled extensively nor have all water quality parameters of interest been examined. Therefore, although past studies and future projections indicate alternatives would produce only small variations in water quality, the possibility of more subtle, long-term effects remains since marine organisms can be affected by very small water quality changes.

Biology

The eight alternatives are summarized with respect to their impacts on biologic systems, including terrestrial habitats, shoreline habitats, the intertidal, Puget Sound, the Duwamish estuary, commercial and sport fisheries, endangered species, and freshwater environments.

Terrestrial Habitats

In general, impacts on terrestrial habitats were considered to be site-specific rather than regional. Site-specific impacts of the inland plants proposed in Alternative H were discussed generally herein as no sites have yet been selected. The impacts are expected to be moderate, but highly limited in extent.

Shoreline Habitat

Combined sewer overflows could affect freshwater marshes in Lake Washington and Lake Union/Ship Canal which are considered to be sensitive habitats as they are highly productive, have limited dilution and mixing properties and support a wide variety of birds, mammals, fishes and other vertebrates. Since combined sewer overflows contain metals, pesticides, toxicants, BOD, solids and other parameters that can stress biota in a variety of ways, marshes would benefit most by Alternative C, Major CSO Control, which could reduce loads and flows by 99 percent to Lake Washington and 93 percent to Lake Union. Relative to Alternative B second best is D, Partial CSO Control, which would reduce these overflows by 83 percent and 61 percent respectively. Alternative F, Southern Strategy, would mean 31 and 17 percent reductions; Alternative H would reduce Lake Washington overflows by 15 percent and those to the Lake Union by 8 percent. Alternatives E and G would continue overflows to these waters as baseline (Alternative B) levels, higher than present and Alternative A levels by 37 and 17 percent for these areas.

The Intertidal

Impacts to the Puget Sound intertidal could be due to sewer overflows (primarily at Elliott Bay and at Alki/West Seattle) and the possibility of treatment plant effluent coming ashore at West Point or near other outfalls. An apparent enrichment of algae at West Point (and perhaps at Alki) plus fecal coliform bacterial levels exceeding state shellfish water standards at all sites in the area are present and future impacts. No effects of effluent have been suggested for intertidal animals except grazers on algae which appear to show increased growth rates.

Puget Sound

The biota of nearshore and offshore waters would be affected more by treatment plant effluent than combined sewer overflows. The size of algae blooms, for which a 15 to 20 percent increase over background levels has been attributed to present discharges, could be increased under all alternatives. Increasing future flows (over the 47 billion gallons per year in present conditions) would be approximately proportional to additional nutrient loads and influence on algae bloom size, since this alternative treatment processes would not remove nitrogen, which apparently is the limiting nutrient in the Sound. Therefore, impacts on algae bloom size would increase in approximately the order of wastewater discharge to the Sound. Alternative A (47 billion gallons per year); Alternatives B, C, D, E, G and H (60 to 66 billion gallons per year), and Alternative F (95 billion gallons per year). The discharge of Renton flow off Alki under Alternative F would place a large nutrient source near one of the two places in the Central Sound where major algae blooms develop.

Overflow volume to the intertidal at Elliott Bay would increase in the following order: Alternative F (304 million gallons per year); Alternatives A, B, E, F, G and H (358 million gallons per year); Alternative D (443 million gallons per year); and Alternative C (448 million gallons per year). CSO control under Alternatives C and D would transfer flows from freshwaters to Elliott Bay; only Alternative F would provide any improvement relative to Alternative B. For Alki Beach, overflow volumes would be: 0.15 million gallons per year under Alternatives C and F; 4.47 million gallons per year under Alternative D; and

5.5 million gallons per year under Alternatives A, B, E, F, G and H. Therefore, the alternative which would have the least impact from combined sewer overflows on the intertidal biota would be Alternative F.

For treated wastewaters, the secondary alternatives (E, F, G and H) would be beneficial to the intertidal, since suspended soilds and BOD would be reduced in any effluent that may wash ashore in a diluted state. Although flows would increase in Alternatives C and D, wastewater solids and organics loads would remain at existing (1975) or no action (Alternative A) levels.

Possible changes in the diversity, abundance and composition of bottom communities are judged to be possibly more related to solids and BOD loads than nutrients and so may be more affected by effluent treatment levels. Thus secondary treatment Alternatives E, F, G and H could decrease the magnitude of the effect seen. Alternatives C and D would maintain it at present (1975) of Alternative A levels but would be a decrease from Alternative B levels. Higher metals levels in Puget Sound biota near the outfalls would be similarly reduced more by E, F, G and H as secondary treatment removes substantially more metals than enhanced primary treatment.

The cause(s) of the elevated incidence of tumorous flatfish at West Point has not been identified. The presence of the outfall pipe and/or its contents may be involved, but to an unknown extent. As a result, the effects of the various alternatives on disease incidence cannot be determined.

Possible effects of overchlorination (possible chlorine toxicity) or underchlorination (inadequate disinfection) could be reduced under certain alternatives, with secondary treatment (Alternatives E, F, G and H). The chlorine contact basins would improve disinfection before discharge, possibly producing lower bacterial counts along beaches, and dechlorization by sulfonation would remove the potential for possible toxic impacts of residual chlorine. Since Alternatives A, B, C and D would not include improved chlorination, possible residual toxicity and/or inadequate disinfection could continue.

Commercial and Sport Fisheries

Migratory fish runs up the Ship Canal through Lake Washington would benefit most by alternatives that control combined sewer overflows. Alternative C, which would control CSO's to Lake Washington by 99 percent and to the Ship Canal by 89 percent relative to Alternative B, would produce the most substantial benefits of all alternatives. Corresponding reductions of 83 and 61 percent for Alternative D would be beneficial also. The other alternatives would include CSO discharge to Lake Washington and the Ship Canal in approximately following increasing order: Alternative F, A, H, B, E and G.

The migratory fish runs up the Duwamish River would be influenced mainly by the effluent flow and quality from the Renton treatment plant. Combined sewer overflows to the Duwamish and to Elliott Bay, would have adverse impacts, but to a lesser degree. All alternatives except C would continue CSO's at existing levels to the Duwamish, a small benefit would result from CSO reduction in Alternative C. Alternative F would produce a minor benefit to Elliott Bay by reducing CSO's to 304 million gallons per year; Alternatives A, B, E, G and H would continue at existing levels, while Alternatives C and D would increase CSO flows and possible impacts on fish in Elliott Bay.

The Duwamish Estuary

Primary impacts for combined sewer overflow would continue under all alternatives except C, wherein a 26 percent reduction relative to Alternative B could be beneficial. Alternative F would produce the most substantial beneficial impact on the estuary, due to transfer of Renton flows to Puget Sound off Alki Point. Secondary impacts from the Renton plant would be related to its discharge of nutrients, toxicants and oxygen demanding materials, as described for each alternative.

Freshwater Environments

These are affected primarily by overflows, except in B, E, and G where construction of a Kenmore parallel interceptor would temporarily disrupt the northwest shore of Lake Washington, and in H where inland plants could discharge advanced treated effluents to Lake Sammamish and the Sammamish River.

CSO's to freshwaters would be reduced most by C and by D, and thirdly by F to a more moderate extent. Other alternatives would continue CSO impacts on biota near discharge approximately at existing levels.

Discharges to inland waters could have important negative effects. Nutrient loads could be sensitive at Lake Sammamish with respect to eutrophication potential. Temperature could be important in the Sammamish River with respect to limits tolerated by migrating fish.

Rare and Endangered Species and Sensitive Habitats

No listed rare or endangered species are recorded from the study area. Critical or sensitive habitats, such as salmon spawning and rearing areas, fish migration routes, waterfowl areas and lake shallows were discussed in other sections. CSO control generally benefited these most.

Energy and Natural Resources

Energy and chemical requirements are summarized below.

The total energy consumption projected for each alternative is shown in Table 3-41. Since energy requirements include power to operate treatment processes, produce chemicals, digest sludge, transport sludge and other activities, the energy requirements increase with the complexity and size of the treatment plant. Thus, energy requirements increase from 24 to 25 million kwh/yr with primary treatment (Alternatives A and B), 34 to 36 million kwh/yr with enhanced primary (Alternatives C and D), 81 to 84 million kwh/yr with secondary (Alternatives E, F and G) and to 124 kwh/yr with secondary plus some advanced waste treatment. The range from 24 to 124 million kwh/yr would be approximately equivalent to that required by 1200 to 6200 houses in the northwest area, less than 1 percent of the total projected energy requirements for the Metropolitan Seattle area for all alternatives. Thus, the impacts from all alternatives would be minor to moderate, adverse, irreversible and long-term.

Secondary effects on the entire Metro area would result from energy consumption at the Renton plant of 28 to 64 million kwh/yr. Thus, the total Metro energy consumption for treatment plant operation in 2005 would range from 53 to 170 million kwh/yr.

Table 3-41

Energy Consumption for Facility Plan Alternatives (million kwh/year)

	A- No Action	B- No Action Pursuant to PL 92-500	C- Major Combined Sewer Overflow Control	D- Partial Combined Sewer Overflow Control	E- Secondary	F- Secondary/ Southern Strategy	G- Secondary/West Point Phaseout Option	H- Deconsolidation/ Reclamation
Puget Sound Plants	24.3	25.4	35.9[a]	34.2	87.5	80.9[b]	85.2[b]	124.3[c]
Renton STP	28.3	52.1	63.6	63.6	55.8	53.4	55.8	45.7
Total	52.7	77.5	99.5	97.6	143.3	134.3	141.0	170.0

(a) Includes Duwamish
(b) Includes Interbay
(c) Includes the four inland plants

Chemicals

Chemical consumption for each alternative is summarized in Table 3-42 (which includes Renton as a regional impact). Like energy consumption, total chemical requirements increase with treatment process complexity and plant size. Chlorine consumption for disinfection would vary from 2940 to 3840 tons per year, tending to increase with larger wastewater volumes and decrease with degree of treatment to achieve comparable disinfection. Sulfur dioxide would be used for dechlorination only when secondary treatment, or more advanced, is provided (Alternatives E, F, G and H). Requirements for lime (CaO), ferric chloride ($FeCl_3$), alum and polymer for solids removal and/or handling would be dependent on treatment process and wastewater flows. Methanol for denitrification, sodium chloride (salt) for recharging ion exchange equipment, and activated carbon, for organics removal would be required only for advanced waste treatment plants.

Although the amount of chemicals required under various alternatives would be substantial, most of the chemical supplies of the inorganic chemicals should continue to be reliable; some synthetic organic materials (such as polymer) may be less readily available in the future since their production is currently linked to oil. Overall, the effect of chemical consumption could have minor, adverse, long-term, irreversible impacts for all alternatives.

Human Environment

Alternatives A (No Action) and B [Metro Comprehensive Plan (No Action Pursuant to PL 92-500)], do not fulfill most agency goals, do not comply with PL 92500, and make few attempts to alleviate the aesthetic problems currently existent.

Alternatives C and D address Metro's goal of best practicable treatment. Combined sewer overflow is a prioritized part of that goal to correct water quality problems. Based on the Draft EIS analysis, these alternatives would reduce bacterial input to Lake Washington public beaches and reduce unpleasant aesthetics associated with combined sewer overflows. However, neither these nor other related water quality impacts would be eliminated by Alternatives C and D. Furthermore, these alternatives do not comply

TABLE 3-42

Natural Resource Committment -- Summary

TOTAL SYSTEM	ALTERNATIVE							
	A	B	C	D	E	F	G	H
	No Action	No Action Pursuant to PL 92-500	Major Combined Sewer Overflow Control	Partial Combined Sewer Overflow Control	Secondary	Secondary/ Southern Strategy	Secondary/West Point Phaseout Option	Deconsolidation/ Reclamation
Chemicals (tons/yr)[2]								
Cl_2	2,940	3,840	3,405	3,385	3,365	3,445	3,225	3,365
SO_2	-	-	-	-	1,015	1,015	1,015	1,015
CaO	-	-	14,740	14,490	10,930	3,650	10,930	11,230
$FeCl_3$	-	-	575	535	520	725	560	500
Alum	-	-	7,440	7,460	-	-	35	655
Polymer	65	80	1,360	1,365	1,150	-	1,150	975
CH_3OH	-	-	-	-	-	-	-	1,155
NaCl	-	-	-	-	-	-	-	11,490
Activated Carbon	-	-	-	-	-	-	-	190

(2) Renton included

with the secondary treatment requirement of PL 92-500.

Alternatives E, F, G and H comply with the secondary treatment requirements of PL 92-500 and certain public support for secondary treatment as expressed in surveys and recent workshops. These alternatives improve the water quality in Puget Sound, but do not control CSO's into inland lakes. Alternatives E, F and G vary in the location of the wastewater treatment facilities, thus determining which local group of people will be most affected. Alternative H deconsolidates with inland wastewater facilities in areas which are comparatively less densely populated.

Land Use

In Alternative A, no new land is used. Alternatives B, C, and D would have minimal expansion at the existing wastewater treatment facilities, so the land at these sites would not be affected. Alternative C phases out Alki, to be replaced by a facility probably at Diagonal Way on the Duwamish, where land was once used by a wastewater treatment facility which was subsequently abandoned. A detailed survey of public sentiment in this area has not been completed, but Metro staff are conducting a study now. More would be done if this conceptual alternative were selected. Placing a facility at Diagonal Way may be compatible with the industrial character of that area. Construction on that site would require a Seattle Shorelines Management permit.

These alternatives also include many combined sewer overflow tanks to store water when the wastewater treatment facilities are overloaded in a storm. Many facilities in Alternatives C and D are along Lake Washington and the Ship Canal; Alternative C also includes 15 tanks along the Duwamish. Many facilities would be constructed near prime shoreline real estate, and/or close to park land and public beaches. These may require permits from the Seattle Shorelines Management plan. The impact of CSO tanks on land use would be adverse, minor, long-term, reversible, local, and probable.

Alternatives E, F, G and H, which include expansion of many of the existing wastewater treatment facilities to secondary treatment, cause greater effect on local land use than already exists. Almost all expansion would require permits from the Shorelines Management Plan (expansion at Richmond Beach would necessitate a similar permit from King County.) In Alternative E, at the West Point site, which is just below Discovery Park, there would be filling of shoreline areas, generally discouraged by the Shorelines Management Plan. In Alternative F, the Harbor Way site on the Duwamish would be incorporated. This site is currently undeveloped, but in an industrial area where wastewater treatment facilities may be compatible.

Alternative G includes development in Interbay at the Golf Park site, which is judged to be difficult to replace recreational land in an urban area (The optional Interbay site along Commodore Way is currently highly developed for marine commerce and seafood industries, which are not necessarily readily transferable).

The Richmond Beach site is in a residential section, but fairly remote from adjacent houses. The Carkeek Park site is in a park, secluded by trees from close-by activity. The West Point site is just below Discovery Park, dominates the use of a scenic point, but cannot be easily seen from the bluffs above. Alki is on prime real estate on a point where its odor is disagreeable to residents of surrounding houses. Wastewater treatment facilities conflict with land use at all developed and proposed; but impacts are part of the trade-off on other impacts such as water quality, biology, and energy use.

Alternative H also uses land for the North and South Lake Sammamish and Kenmore wastewater facilities. Little information is available on land use at these sites; more environmental analysis would be completed if this conceptual alternative were selected.

The North and South Lake Sammamish facilities, and probably the Harbor Avenue and Diagonal Way facilities, would have to comply with constraints of the State Flood Zone Act.

Land use impacts of wastewater treatment facility placement are adverse, minor-to-major, long-term, local, reversible only at large expense, and definite.

Interceptors which would require land accessibility include the following: all alternatives but A include the Val Vue connection; all but A and H include the Redmond connection. Little information is available on the routes or surrounding land uses. The Kenmore parallel interceptor, included in Alternatives, B, E and G, would be built along the northwest Lake Washington shoreline, at points is submerged in the lake. Installation of this facility would require a Seattle Shorelines Management Plan permit. Almost none of the shoreline bordered by this interceptor is designated public parkland. The major impact on land use of this interceptor would be during construction, at which time the impact would be adverse, major, short-term, reversible, local, and probable. After construction is completed, the impact on land use would be minimal as for the existing Kenmore interceptor.

Alternatives C, D and F include the North Creek-Hollywood connection. This runs parallel to an already existing connection; after construction stops little impact on land use is expected, since this connection is underground. If the connection runs within 200 feet of the Sammamish River, a SSMP permit will be required.

Alternatives E, F and G include a connection from Carkeek Park to West Point (to Interbay in G) which borders the Puget Sound shoreline. This would pass through the Golden Gardens Park, residential areas, and near a railroad track. Data to determine the impact of this line are not available.

Alternatives C, F and H include tunnels: The tunnels for Alternatives C and F would be built from Alki to Duwamish; the tunnel for Alternative H would connect Kenmore to Richmond Beach. Although these would have minimal longgerm impact on land use, they could cause disturbance to residents above certain portions of the tunnels during the blasting often used in construction.

Alternative G includes both a force main and interceptor connecting West Point and Interbay through Discovery Park and major downtown industrial districts. Information is not available to discern the impact of these routes. More environmental analysis would be conducted if this conceptual alternative is selected.

All alternatives but A include the Montlake and Third Avenue West regulator stations for CSO control. The Montlake regulator station is being constructed near a major bridge across the Ship Canal into the University of Washington Campus. Adequate information on the Third Avenue West regulator station is not available to assess the impacts of its installation.

Alternatives and Impacts
Summary

Population

All the alternatives except B would probably result in a slight facilitation of regional growth over the long term due to the improvement or preservation of water quality by reducing either combined sewer overflows or wastewater pollutant loads. It is concluded that such protection of water quality will contribute to the continuation of the region's current national image as a desirable place to live due to the generally high quality of the natural environment. While the specific cause-effect relationships which contribute to such impacts are difficult, if not impossible, to quantify, it is reasonable to expect that nationally more economic growth will tend to occur in the regions of higher environmental quality. If regions, such as Puget Sound, which presently have a relatively high environmental quality, maintain or improve these conditions, it is logical to expect that the encouragement to economic development will be greater than if they are allowed to deteriorate. This impact can be either beneficial or adverse depending on the characteristics of the development which occurs and the values of the people affected.

Legal and Institutional

Alternatives A, B, C and D do not comply with PL 92-500. This is considered an adverse, major, long-term, regional in extent, reversible and probable impact. As indicated in Chapter II, a fine for noncompliance could be as high as $10,000 a day. Noncompliance with PL 92-500 could result in litigation and could restrict Metro's ability to receive federal or state funds for wastewater facility construction.

Alternatives E, F, G and H would fulfill the requirements of PL 92-500 and Washington NPDES regulations that secondary treatment be established. This impact is beneficial, major, long-term, reversible, and definite.

Timing of secondary treatment plant construction has not been fully resolved. The Washington State NPDES permit, which requires secondary treatment at the four PUget Sound plants by July 1, 1977 to comply with PL 92-500, recognized the ongoing Facility Plan and Draft EIS by

June 1978. According to the Draft Facility Plan schedule, most secondary treatment plant capacity was scheduled to be completed by 1985, which does not meet the 1983 best practicable treatment date of PL 92-500. Therefore, the Facilities Plan construction schedules will be changed accordingly.

Agency Goals

Alternative A would not improve conditions by 2005 over existing conditions, which are themselves a reflection of agency steps toward a goal of cleaning the environment when compared to former water quality conditions. Alternative A does not comply with PL 92-500, which is one of the objectives mentioned in Goals for Seattle, nor does it improve water quality, a goal of several agencies.

Alternative B is slightly better than Alternative A in fulfilling the King County Utilities Development policy of "installing trunk utility lines in advance or at the time of development:, but may not fulfill its policy that "where pollution conditions now exist, all possible steps should be taken to correct such conditions." The potential for water quality degradation would not meet most agency goals.

Alternatives C and D were originally established to fulfill Metro's goal of best practicable treatment and correcting local water quality. Some improvements would result which would be favorable, major, long-term, irreversible, and probable.

However, these alternatives do not fulfill the objectives of Goals for Seattle, which states, "the city should undertake efforts to meet Federal Water Pollution Control Act requirements by 1984." This impact is adverse, major, long-term, can be reversed by implementing secondary treatment and definitely would occur if Alternatives C and D are implemented.

Alternatives C, F and G on a local basis, do fulfill the objective of the PSCOG that it is in the public interest to maintain the natural beauty and liveability of the region, by phasing out facilities at certain locations. Alternatives C and F phase out Alki, Alternative G has the option of phasing out West Point, and makes Carkeek Park service for wet weather flows only. These are favorable on the local level, especially at Alki, which has an odor problem; but for each plant that is phased out there must be one constructed to replace it.

Of the alternatives which comply with PL 92-500, Alternative E - Secondary best fulfills the goal of the PSCOG that "the pattern of development which produces the least cost in new public utilities, facilities, and services shall be encouraged within feasible limits".

Employment

Employment potential for each regional alternative has been summarized or estimated from information provided in the Draft Facility Plan. Table 3-42 summarizes the construction, operation and maintenance employment for the regional wastewater facilities.

The operation and maintenance jobs for Metro treatment plant operating staff in 2005 would range from 66 to 188 permanent positions for the Puget Sound plants. (Collection system maintenance personnel are not included in these estimates.) The operating staff would increase under alternatives that involve more complex processes or treat larger flows. The operating staff employment opportunities would represent a minor, beneficial, long-term benefit to the region for Alternatives C, D, E, F, G and H (since staff would increase relative to Alternative B).

Construction employment would generally involve more jobs than operations, but over a shorter term. For comparative purposes, the construction jobs were estimated within 5 years. Estimates in Table 3 - 42 are for a 5 year duration. Construction for the Puget Sound plants, combined sewer overflow controls, outfalls, transfer interceptors and/or other facilities would range from 150 jobs in Alternative B to 650 jobs in Alternative G (since no capital funds would be expended under Alternative A, no jobs would be provided). The relative number of construction jobs is approximately related to the relative capital costs for the alternatives. Construction jobs would be a minor to moderate, short-term, extensive benefit to the region, but it is not certain whether these jobs would replace other employment opportunities from government funding or represent additional employment at the time of construction.

Table 3 - 42

Construction, Operation and Maintenance Employment

Jobs: Operation and Maintenance

	Alternative							
	A	B	C	D	E	F	G	H
Puget Sound*	66	86	96	76	115	119	148	188
Renton	21	41	76	76	70	72	70	58
Total	87	127	172	152	185	191	218	246

Jobs: Construction

	Alternative							
	A	B	C	D	E	F	G	H
Puget Sound*	0	150	400	200	350	450	650	550
Renton	0	200	350	350	250	350	250	150
Total	0	350	750	550	600	800	900	700

*All plants or other projects excluding service area

Costs

Capital costs for wastewater facilities construction, excluding Renton, are shown in Table 3-13 based on 1976 cost estimates contained in the Draft Facility Plan. Costs vary from no capital expenditures (Alternative A) to $361,800,000 (Alternative G). The treatment process, plant location, wastewater flow and discharge point, combined sewer overflow controls and/or transfer interceptors to achieve certain service areas are major factors in determining costs.

Alternative G, the most capital intensive alternative at $361,800,000, would include $250,500,000 for the Interbay secondary treatment plant. Since primary treatment would be required there (duplicating existing primary treatment capacity at West Point), the total plant costs would be two to three times the cost of adding secondary treatment at West Point ($86,000,000 in Alternative F and $120,300,000 in Alternative E).

Alternative H (Deconsolidation/Reclamation) would be the second most expensive alternative at $307,700,000. Much of the cost for this alternative would be due to the construction of new advanced waste treatment facilities at Kenmore and North and South Lake Sammamish, which would account for a total of $131,200,000.

Alternatives C (Major CSO Reduction) and F (Secondary/ Southern Strategy) are the next most expensive alternatives at $250,800,000 and $286,500,000, respectively. In Alternative C, an expenditure of $112,800,000 would be required for combined sewer overflow control. Much of the cost of Alternative F would be due to the cost of building a new secondary facility at Duwamish, which would cost $148,800,000.

Alternative E (Secondary) would cost $212,800,000 which is $73,700,000 less than Alternative F and $149,000,000 less than Alternative G. Although all three would achieve comparable levels of secondary treatment, the greater costs required in Alternatives F and G would be primarily due to constructing the new Duwamish and Interbay facilities, respectively, rather than upgrading facilities which exist already. These cost savings are substantial in Alternative E.

Alternative D (Partial CSO Control) would cost $106,800,000. Relative to Alternative C, Alternative D would cost $144,000,000 less, primarily due to more limited CSO control; Alternative D would result in an additional 287 million gallons per year of combined sewer overflows. Although an exact benefit/cost ratio of CSO control has not been calculated, the incremental benefit from Alternative C relative to Alternative D appears low compared to the $500,000 capital cost for each million gallons of CSO control on an annual basis.

In Alternative B [Metro Comprehensive Plan (No Action Pursuant to PL 92-500)], wastewater facilities would cost $81,900,000; of this, $14,200,000 would be due to sludge facilities enlargement at West Point and $12,700,000 for Alki plant modifications.

Capital costs at Renton, a secondarily impacted facility, would be as shown in Table 3-13. They would be predominantly due to enlargement of the facility and/or upgrading treatment to include nitrification and filtration. Alternatives C, D and F, which treat the largest flows at Renton facility (99 mgd average) would cost the most at 192 to 195 million dollars. Alternatives E and G, with lower 86 mgd average flows, Alternative H, with 72 mgd flows, would cost $94,300,000. Under Alternative B, average costs for 86 mgd average flow would be %51,000,000 for secondary treatment but no nitrification and filtration. Alternative A (No Action) would have no capital costs.

Estimated Metro user charges per equivalent connection, summarized in Table 3-14, would range from $5.25 to $13.70 per month (average for the next 20 years), depending on the capital and operating cost for each alternative and probability for federal and state funding. Since Alternatives A, B, C and D do not comply with the secondary treatment requirements of PL 92-500, they would not be eligible for federal and state construction grant funds, so Metro users would be directly responsible for 100 percent of construction costs. Estimated monthly user charges for Alternatives A, B, C and D would be $5.25, $8.40, $13.70 and $11.10, respectively, assuming no grant funding. If all facilities are eligible for grants until 1995, estimated monthly user charges would be $6.80, $6.85, $7.45 and $7.85, respectively, for Alternatives E, F, G and H. If future capacity beyond 1985 is not grant eligible, Alternatives E, F, G and H would result in average user charges of $8.00, $8.60, $8.75 and $9.70 per month.

Thus, Alternatives C and D, without federal funding, would cost Metro citizens more in terms of estimated monthly user charges than Alternatives E, F, G and H with federal funding.

Social, Recreational and Cultural

According to public surveys (HRPI, 1976), input from public meetings, and reports of citizen advisory committees, it appears that a majority of citizens within the Metro area would favor upgrading wastewater facilities to secondary treatment. Alternatives E, F, G and H would meet this objective, while Alternatives A, B, C and D would not.

Under Alternatives B, E, F, G and H, only the Montlake and Third Avenue West regulator stations would be constructed for the control of combined sewer overflows. Only the Kenmore parallel interceptor would be installed under Alternatives E and G for CSO control.

Substantial combined sewer overflows would continue near public beaches under Alternatives A, B, E, F, G and H. Therefore, coliform levels exceeding health standards at swimming beaches along Lake Washington could continue. This is considered adverse, major, long-term, reversible, and possible impact.

Impacts on the parks or recreational areas near West Point, Alki and Carkeek Park are discussed in detail in site-specific documents (Volume II). Since the West Point plant would continue under all alternatives, it could affect recreational use of nearby Discovery Park to a limited degree. At Alki, the plant site would be expanded to an adjacent playing field under Alternatives E, G and H; the site could be abandoned under Alternative C or F. At Carkeek Park, upgrading to secondary treatment under Alternative H would require using 1.1 acres now available for picnicking. In Alternative G, the Golf Park in Interbay would be converted from its present recreational use to wastewater treatment.

Archaeological and Historical

It has been determined that any archaeological sites may have occurred at West Point, Carkeek Park, Richmond Beach and Alki would have already been destroyed by former construction. Therefore, construction under all alternatives could not destroy archaeological sites (Jerry Jermann, 1976). Across the Duwamish River from the Diagonal Way site, probably used for Alternative C, is a recently discovered archaeological site. Therefore, additional investigations should be conducted at the site if this alternative is selected. No information is available on archaeological sites on the proposed sewage treatment facilities at Harbor Ave., Commodore Way, the Golf Park, North or South Lake Sammamish, or Kenmore; nor for the interceptor routes or regulator stations. These sites should also be investigated. For the historical sites described in Appendix E, none are known to exist at any proposed construction sites.

Health and Safety

For Alternatives A, B, E, F, G and H, a probable negative impact would be the associated violations of coliform bacteria standards at Lake Washington public beaches.

For recreational shellfish collectors, risks from consuming contaminated shellfish from water that exceed commercial shellfishing standards for coliform bacteria could continue. Because the present source of bacteria has not been identified, impacts from control measures are not certain.

However, it appears that more effective wastewater disinfection under Alternatives E, F, G and H would be beneficial to improving water quality in shellfishing areas. At Alki, combined sewer overflow control under Alternatives C and F would benefit the local shellfishing beach.

Another highly unlikely safety hazard for all alternatives is accidental leakage of chemicals when they are in transport, or handled on site. Although nearly every U. S. water and wastewater treatment facility uses chemicals, there have been very few chemical-related accidents.

Construction risks to safety would be the same as for other construction of a similar nature; they would be adverse, minor, last only for the duration of construction, may be reversible, and are unlikely.

Health and safety risks for chemical and sludge transport and construction would be proportional to the transport and construction involved in each alternative.

Under Alternative F, oxygen activated sludge would be installed at West Point. With this method of secondary treatment, if the oxygen mixed into the activated sludge basin were to contact hydrocarbons (e.g., gasoline) in the presence of a spark, there could be an explosion. However, this situation should never arise. Oxygen activated sludge facilities are designed to provide continuous monitoring of hydrocarbon concentration. An alarm will sound far below dangerous hydrocarbon levels, and oxygen would automatically be vented to bypass the activated sludge basin. The impact of an explosion could be adverse, major, long-term, reversible, but would be highly unlikely. Although oxygen activated sludge facilities are used around the country, there has not yet been any incidence of explosion.

Aesthetics and Nuisance

Introducing secondary treatment at West Point, Carkeek Park, Richmond Beach, Interbay, Duwamish, Alki, or other sites under various alternatives, would generate some site-specific nuisance impacts for local residents, as discussed in more detail in Volume II for various sites. However, surveys and public workshops have generally indicated that in the locales of these facilities, "cleaning up the environment" was considered a higher priority by more people (60 percent) than such aesthetic issues as hiding the facility (6 percent) (HRPI, 1976). These aesthetic and nuisance impacts are rated as adverse, minor, long-term, reversible, and definite.

Under Alternative G, installation of a facility in Interbay at the Golf Park site would be a nuisance. In excavation in Interbay of the garbage which accumulated over 20 years, it is possible that odorous sulfur dioxide and methane gas would be released; when in operation, the facility would still release odors. Locating the plant in a valley would make it visible to residents from adjacent hillsides.

A facility at the optional Interbay site, Commodore Way, would also exert nuisances after installation. Further, placement of a facility in the Commodore Way area would disrupt an entire business community.

Alternatives C and D would decrease the combined sewer overflows, which are a visual nuisance and potential health hazard. The impact of this would be favorable, major, long-term, and probable.

Construction of the interceptors and regulator stations would cause an adverse, minor, short-term, reversible, and probable nuisance effect, especially at the Montlake regulator station, where construction would occur along a major bridge across the Ship Canal.

The Duwamish-Alki tunnel in Alternative F, and the Kenmore outfall tunnel in the Alternative H, would be a short-term, reversible, local, and probable nuisance, especially for the Duwamish-Alki tunnel. Blasting often associated with tunneling could disturb local residents in these highly populated districts.

CHAPTER IV

CITIZEN AND AGENCY INVOLVEMENT

Citizen and agency involvement has been an integral component of the Regional 201 Facility Planning program, the Environmental Impact Statements (EIS), and the 208 Areawide Waste Treatment Management Program. Each of these efforts for the Metro service area has included citizen and agency participation as mandated by the Water Pollution Control Act Amendments of 1972 (PL 92-500). More importantly, the roots of citizen involvement in Metro activities are based on its original conception: Metro was voted into existence by environmentally concerned citizens in 1958. Since that time, efforts by Metro and citizens have continued the public input into water quality planning and environmental assessment.

The interagency involvement in this water quality planning process is also unique. In a novel "piggybacking" process, Metro, the Washington Department of Ecology (DOE), and the United States Environmental Protection Agency (EPA) signed a Memorandum of Understanding in 1976 for joint participation in the environmental assessment process. By this agreement, the three agencies aimed at including local, state and national concerns and issues in the environmental assessment process. The piggybacking approach of preparing the 201 Facility Plan and the impact statement concurrently was also envisioned as a method for ensuring feedback between the assessment and planning efforts as well as a technique for saving time and money.

One benefit of the piggybacking process has been the enhanced communication among the three sponsoring agencies and other parties (e.g., Seattle). Since October 1976, biweekly coordination meetings on various issues related to the environmental assessments have involved personnel from Metro, DOE, EPA, the 201 Facilities Planning consultant (Metropolitan Engineers), and the EIS consultant (James M. Montgomery, Consulting Engineers, Inc.). These coordination meetings have explored issues such as EIS format and content, community involvement programs, growth and population distribution effects, wastewater treatment and sludge management

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alternatives, and shoreline management. Interest by other agencies has been expressed by attendance at some coordination meetings by representatives from the City of Seattle, the Puget Sound Council of Governments, King County, and others.

In addition to providing guidance on the environmental impact process and reviewing its progress, the three agencies have performed another vital function: funding. As a part of the Step I facilities planning process, the EIS activities are funded jointly by Metro (10%), DOE (15%), and EPA (75%). Similarly, the ongoing community involvement program for planning and assessment has been developed and funded by the three participating agencies.

Other agencies will be involved in reviewing the environmental documents; their names are listed in the beginning of this document. Agencies having direct or indirect jurisdiction over Metro facility planning on the state or local level include the Department of Ecology, Office of the Governor, Department of Game, Department of Fisheries, Department of Natural Resources (state agencies), Puget Sound Council of Governments, the City of Seattle and King County. Agencies with expertise useful to the Metro EIS process include the Department of Social and Health Services, State Ecology Commission (state agencies), Seattle City Council Staff, Seattle Engineering Department, Puget Sound Council of Governments, and King County Health Department. The Parks and Recreation Commission, Oceanographic Commission, Utility and Transportation Commission, Department of Commerce and Economic Development (state agencies), City of Edmonds, City of Lynnwood, City of Black Diamond are also expected to be interested.

Component agencies served by Metro will also be reviewing the EIS. Included are thirteen cities (Algona, Auburn, Bellevue, Bothell, Brier, Issaquah, Kent, Kirkland, Redmond, Lake Forest Park, Renton, Seattle, and Tukwila), eleven sewer districts (Bryn-Mawr-Lakeridge, Cascade, East Mercer, Eastgate, Highland, Lake City, Mercer Island, N.E. Lake Washington, Rainier Vista, Ronald and Val Vue), six water districts (Alderwood, #35 Skyway, #82 Pine Lake, #104 Woodinville, #107 Newport Hills and #108 Fairwood), two sewer and drainage districts (King County Districts #3-Richmond Beach and #4-Skyway Park), and two other members (Sammamish State Park and Shorewood Apartments).

Federal agencies are also involved in the review process, as indicated in the EIS distribution list.

The program for establishing agency and citizen involvement in the 201 facilities planning, environmental assessment and 208 areawide waste treatment management process has been coordinated, planned and implemented through the Metro staff community involvement section. The program also receives periodic input from DOE, EPA and Metro's consultants.

In the spring of 1976, Metro prepared a community involvement plan. Strategies were developed to reach a variety of interested groups including the general public, future voters, environmental groups, special interest groups, recreational groups, technically-oriented individuals, governmental units, and industrial and agricultural interests.

One technique for community involvement was circulation of "Clear Water Watch", a brochure describing facets of the water pollution control efforts under Sections 201 and 203. More than 28,000 brochures were distributed in the June 1976 mailing. Since July 1976, a "Clear Water Watch" newsletter has been mailed to about the same group, plus any newly interested citizens who are identified through public meetings or other contacts. In addition to the one-page newsletter, Metro provides a more detailed technical supplement. It is mailed automatically to nearly 1,000 persons, and to anyone who requests it based on a notice of availability printed in every edition of the newsletter.

Community meetings have been held by Metro, its consultants and other agencies to describe alternatives, assess public opinion, determine important issues, and receive public input from citizens. In May and June 1976, community meetings were held in the vicinity of Metro's four primary wastewater treatment plants along Puget Sound: West Point, Alki, Carkeek Park and Richmond Beach. More such meetings were held in September and November 1976. During these meetings, citizens were informed of three strategies under consideration by Metro: "no action" strategy (continuation of Metro Comprehensive Plan with continued primary treatment at the Puget Sound plants), "legal" strategy (secondary treatment at Puget Sound plants) and "goal" or "merit" strategy (control and treatment of combined sewer overflows with continued primary treatment at Puget Sound plants). Discussion of meetings and responses in the West Point, Alki, Carkeek Park and Richmond Beach communities is included in the site-specific environmental documents (Volume II of this series). Summaries of the meetings were prepared by Metro and mailed to persons attending the meetings as part of the Clear Water Watch community involvement program.

Public workshops were held in conjunction with the preliminary Draft EIS (Regional Analysis and site-specific documents). These workshops, planned by Metro, DOE and EPA, informed the public about the updated facilities plan and environmental documents, which now address eight system-wide or regional alternatives. Comments from participants on the revised set of alternatives were solicited at the workshops in May and June 1977. One series of citizen workshops focused on site alternatives and one technical workshop (for representatives from environmental groups, educational institutions, staff from other agencies, and other technically interested citizens) emphasized system-wide or regional issues. Both types of workshops provided inputs and comments to Metro prior to preparation of the Draft EIS/EA's.

The technical workshop held May 25, 1977 on the Preliminary Draft EIS (Regional Analysis) consisted of governmental staff, community organization representatives, consultants and citizens; several questions and suggestions were made concerning the Regional EIS.

1. Citizens questioned whether the 201 plan was proceeding in a vacuum or whether the 201 and 208 studies were being coordinated. The two processes are proceeding concurrently, with Metro as the lead agency in each. The 208 workshop communicated some of the 208 concerns to the consultants, particularly on-site disposal systems which are discussed in portions of Chapter III of the Draft EIS.

2. People attending the regional workshop requested breakdowns of cost and energy be included in the Draft EIS; this has been done in Chapter III.

3. Questions on growth and decentralization were raised. Readers are referred to the Impacts of Growth section in Chapter III of the Draft EIS. Maps on service areas and land use and details of plant sizing are included in Chapters II and III.

4. Other comments were that the EIS should be understandable by the public. The Draft EIS has been prepared with this point in mind, including summary materials.

5. The question was raised as to how the alternatives encourage or discourage water conservation. Details of methods to conserve water considered in alternatives development and impact on treatment plant sizing and cost are presented in Chapter III.

6. Questions were made as to why the agencies are considering illegal alternatives. The Metro staff has stated previously that primary discharges do not

adversely affect Puget Sound and that combined sewer overflows are a more important water quality problem locally. The EIS has reviewed recently developed information to systematically evaluate these and other possible impacts in an independent manner. Consequences of not complying with secondary treatment PL 92-500 are described in Chapters II and III, including cost and financing impacts.

7. One person noted that the EIS should consider the impact of point and non-point source discharges on water quality. The EIS consultants requested information on loading rates to Puget Sound from municipalities, industries, runoff, aerial fallout, and other sources. This mass loading information was not available. To the extent possible, EIS compares inputs from various sources.

8. The suggestion was also received that sludge alternatives be in the Draft EIS. They are, to the extent possible, based on proposed sludge management methods in the Draft Facility Plan, which is an interim solution.

9. The need for alternatives with both combined sewer overflow (CSO) control and secondary treatment was mentioned. Chapter III discusses possibilities for developing new hybrid alternatives.

Workshop response to various alternatives was summarized as follows:

Alternative A. (No Action) Not worth much discussion.

Alternative B. (Comprehensive Plan) This is not only illegal, but allows no flexibility to provide secondary treatment.

Alternative C. (Major CSO Control) This is illegal, and fails to deal with the obsolescence of the existing plants. This incurs a tax burden because it is not grant-fundable, but it does reduce the CSO problem.

Alternative D. (Partial CSO Control) Similar to Alternative C, but with less CSO control.

Alternative E. (Secondary) Although noted as the least costly of the legal alternatives, it was criticized for inflexibility to meet future water quality needs; insufficient emphasis on CSO; loss of Carkeek investment; and the greatest negative impact on Puget Sound shoreline (due to fill at West Point).

Alternative F. (Secondary Treatment-Southern Strategy) This alternative was criticized for poor utilization of valuable industrial land. The adverse effect of fill on the natural life must also be evaluated. There was concern about ultimate water quality and future expansion.

The benefits of this plan included: better cost/benefit ratio than for "E"; and significant Duwamish water quality benefits. It was suggested that this alternative also offered a better location and improved combination of treatment and CSO control than for other plans. Further evaluation of cost and flexibility of the plan is needed.

Alternative G. (Secondary Treatment-West Point Phaseout Option) Participants credited this plan with providing the possibility of reclamation of land (beach area), improving water quality, and assuring the most acceptable level of treatment.

Group concerns regarding this proposal centered on the Commodore Way site which is a business/residential area. The impact of the plant on the Commodore Way area was questioned relative to loss of tax revenue and jobs or recreation space. This does not solve the CSO problem, and presents the highest capital costs and second highest operation and maintenance costs.

Alternative H. (Deconsolidation/Reclamation) On the whole, this alternative was viewed more favorably. The decentralization and equal distribution of cost were mentioned. The reclamation of sludge was cited as valuable. The question of who will pay for the smaller plants was raised.

Prior to the formal public hearings on the Draft EIS, the three agencies are considering holding a prehearing informational workshop, the size and structure of which would be based on the interest level of those receiving the Draft EIS. Next, four public hearings on the Draft EIS documents are scheduled for October-November 1977 in the West Point, Alki, Carkeek Park and Richmond Beach areas; one hearing will be scheduled for regional impacts. A hearing on the Final EIS, scheduled for March 1978, will complete the formal community involvement phase.

Metro has also contacted special interest groups for input to the water quality planning process. In 1976, Metro staff and consultants visited about 45 groups including civic community and school organizations. About 40 conservation and environmental groups were contacted by Metro in January 1977 to explain the facilities planning and EIS/EA process and to encourage participation of these groups.

Questionnaires and surveys have also been used to learn citizen concerns and preferences. Club meetings, community meetings, a weekend survey of Carkeek Park users and an areawide survey conducted by the Gilmore Research Group have been used to obtain information. Results of the surveys were summarized in June 1976 by Metro in the first quarterly report of Clear Water Watch.

Another important aspect of the community involvement program has been the Citizens' Water Quality Advisory Committee (CWQAC). Formed in the spring of 1976, the CWQAC is comprised of 27 members who represent, roughly, the nine county districts and who provide Metro Council and staff with a regional overview of citizen water quality concerns. The CWQAC has also formed task forces on treatment plants, sludge disposal and regional goals and policies.

From the above discussion, it can be seen that there are many ongoing and planned methods for obtaining citizen and agency involvement in the 201 facilities planning and EIS/EA process. For details of site-specific programs at West Point, Alki, Carkeek Park, and Richmond Beach, the reader is referred to Volume II of this series.

APPENDIX A
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APPENDIX B
LIST OF ELEMENTS OF THE ENVIRONMENT

WAC 197-10-444 LIST OF ELEMENTS OF THE ENVIRONMENT

(1) Every EIS shall have appended to it a list of the elements of the environment in subsection (2), (3) and (4) of this section. The lead agency shall place "N/A" ("not applicable") next to an item when the proposal, including its indirect impacts will not significantly affect the area (or subarea) of the environment in question. Items marked "N/A" need not be mentioned in the body of the EIS. Subsections (2) and (3) of this section correspond in subject matter to the questions contained in the environmental checklist used for threshold determination, and the questions in the checklist may be used to interpret this outline listing.

(2) ELEMENTS OF THE PHYSICAL ENVIRONMENT

(a) Earth
(i) Geology.
(ii) Soils.
(iii) Topography.
(iv) Unique physical features.
(v) Erosion.
N/A (vi) Accretion/avulsion.

(b) Air
(i) Air quality.
(ii) Odor.
(iii) Climate.

(c) Water
(i) Surface water movement.
(ii) Runoff/absorption.
(iii) Floods.
(iv) Surface water quantity.
(v) Surface water quality.
N/A (vi) Ground water movement.
(vii) Ground water quantity.
(viii) Ground water quality.
(ix) Public water supplies.

(d) Flora
(i) Numbers or diversity of species.
(ii) Unique species.
N/A (iii) Barriers and/or corridors.
N/A (iv) Agricultural crops.

(e) Fauna
(i) Numbers or diversity of species
(ii) Unique species.
(iii) Barriers and/or corridors.
(iv) Fish or wildlife habitat.

(f) Noise

N/A (g) Light and glare

(h) Land use

(i) Natural resources
(i) Rate of use.
(ii) Nonrenewable resources

(j) Risk of explosion or hazardous emissions

(3) ELEMENTS OF THE HUMAN ENVIRONMENT

(a) Population

N/A (b) Housing

(c) Transportation/circulation
(i) Vehicular transportation generated.
N/A (ii) Parking facilities.
N/A (iii) Transportation systems.
N/A (iv) Movement/circulation of people or goods.
N/A (v) Waterborne, rail and air traffic.
(vi) Traffic hazards.

(d) Public services
N/A (i) Fire.
N/A (ii) Police.
N/A (iii) Schools.
N/A (iv) Parks or other recreational facilities.
N/A (v) Maintenance.
(vi) Other governmental services.

(e) Energy
   (i) Amount required.
   (ii) Source/availability.

(f) Utilities
   (i) Energy.
N/A (ii) Communications.
   (iii) Water.
   (iv) Sewer.
   (v) Storm water.
   (vi) Solid waste.

(g) Human health (not including mental health)

(h) Aesthetics

(i) Recreation

(j) Archeological/historical

(4) The following additional element shall be covered in all EISs, either by being discussed or marked "N/A," but shall not be considered part of the environment for other purposes:

N/A (a) Additional population characteristics
   (i) Distribution by age, sex, and ethnic characteristics of the residents in the geographical area affected by the environmental impacts of the proposal.

APPENDIX C
AIR POLLUTION EMISSION CALCULATIONS

In order to assess the air quality impacts of sludge trucking and personnel traffic, the following simple procedure was used. Assuming that treatment plant personnel on the average live within about 5 miles of work, the number of personnel needed to man a facility was multiplied by 10 miles (to account for the round trip), and that product multiplied by 1971 EPA emission factors for automobiles. These emission factors, contained in the EPA report "AP-42", were the most up-to-date figures obtainable. Because future emissions will be subject to stricter controls, use of the 1971 factors gives a "worst case" impact. Even so, the total traffic impact is a very small portion of 1% of Seattle's total daily emissions. To calculate the sludge trucking emissions, the number of sludge trips necessary per treatment plant per day was doubled (to account for round trips) and multiplied by the number of miles travelled between the given treatment plant and destination (see accompanying table). This number was in turn multiplied by 1973 emission factors for heavy duty diesel trucks. These factors, also contained in EPA's report "AP-42", are included in the following table.

"AP-42" EMISSION FACTORS

HEAVY DUTY DIESEL TRUCKS (1973)

Hydrocarbons (total)	1.38	grams/mile
Carbon monoxide	8.61	
Nitrogen oxides	6.27	

AUTOMOBILES

Hydrocarbons	3.07
Carbon monoxide	39.6
Nitrogen oxides	5.06

SLUDGE TRUCK MILEAGE

West Point	to	Cedar	Hills	Landfill	17	miles
Alki	"	"	"	"	14.5	"
Carkeek Park	"	"	"	"	17.5	"
Renton	"	"	"	"	7	
Interbay	"	"	"	"	16	
Duwamish	"	"	"	"	14	
Richmond Beach	to	West	Point		6	
Carkeek Park	to	West	Point		3.5	

APPENDIX D

SUPPLEMENTARY FIGURES AND TABLES

Figures

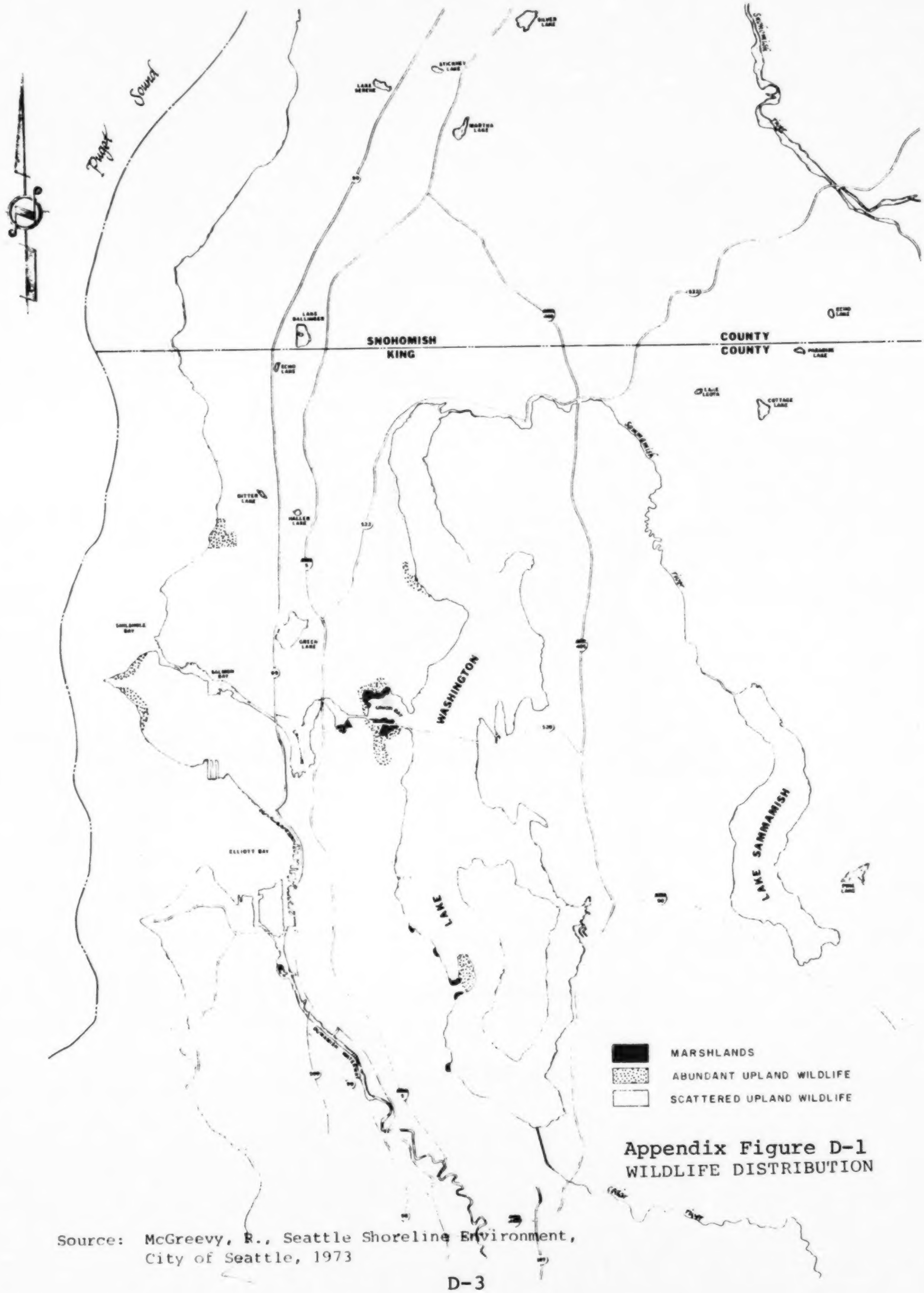
Appendix Figure D-1	Wildlife Distribution
Appendix Figure D-2	Feedback Cycle of Net Currents in Puget Sound.
Appendix Figure D-3	Vertical Profiles of Net Currents
Appendix Figure D-4 (2 pages)	Commercial and Sport Fisheries in the Study Area.

Tables

Appendix Table D-1	Criteria for State of Washington Water Quality Standards
Appendix Table D-2	Terrestrial and Marshland Fauna of the Sewerage Area.
Appendix Table D-3	Addenda to "List of Fauna of the Sewerage Area"
Appendix Table D-4	Summary, Overflow Study, August 1976
Appendix Table D-5	Selected Water Quality Criteria Proposted by U.S. EPA 1975
Appendix Table D-6	Levels of Metals in Biota at Denny Street Overflow, August 1976.
Appendix Table D-7	Fecal Coliform Effluent Limitations and Monitoring at Metro's Puget Sound Treatment Facilities
Appendix Table D-8	Total Coliforms Standards Violations for Puget Sound Shoreline Stations
Appendix Table D-9	Chlorine Toxicity to Marine Organisms
Appendix Table D-10	Rare, Threatened or Endangered Animal Whose Range Includes the Green River Sewerage Area.

Appendix D

Appendix Table D-11 Recommended Temperatures
Appendix Table D-12 Recommended Dissolved Oxygen Levels


Puget Sound
SILVER LAKE
STICKNEY LAKE
LAKE SERENE
MARTHA LAKE
LAKE BALLINGER
SNOHOMISH COUNTY
KING COUNTY
ECHO LAKE
PARADISE LAKE
LAKE LEOTA
COTTAGE LAKE
BITTER LAKE
HALLER LAKE
SHILSHOLE BAY
GREEN LAKE
SALMON BAY
WASHINGTON
LAKE SAMMAMISH
ELLIOTT BAY
LAKE
■ MARSHLANDS
▨ ABUNDANT UPLAND WILDLIFE
☐ SCATTERED UPLAND WILDLIFE

Appendix Figure D-1
WILDLIFE DISTRIBUTION

Source: McGreevy, R., Seattle Shoreline Environment,
City of Seattle, 1973

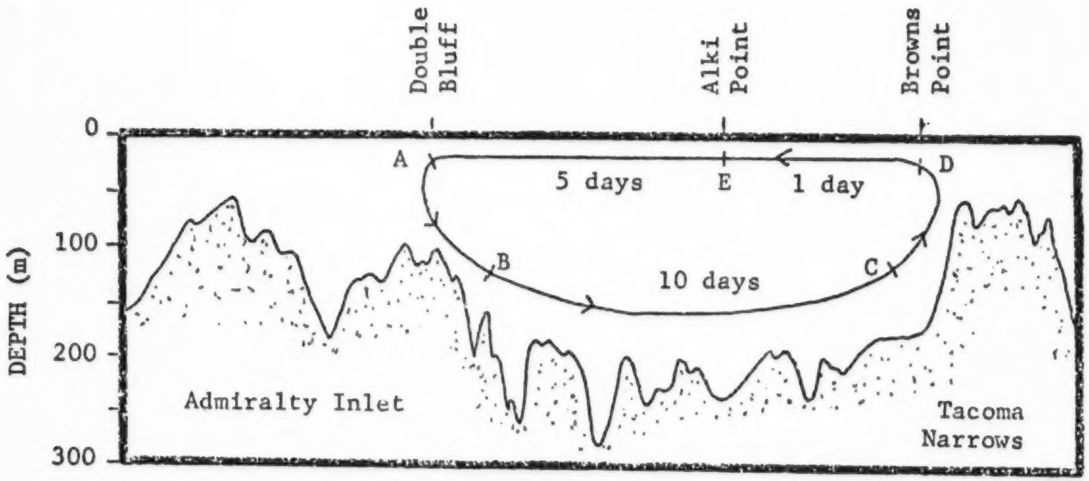
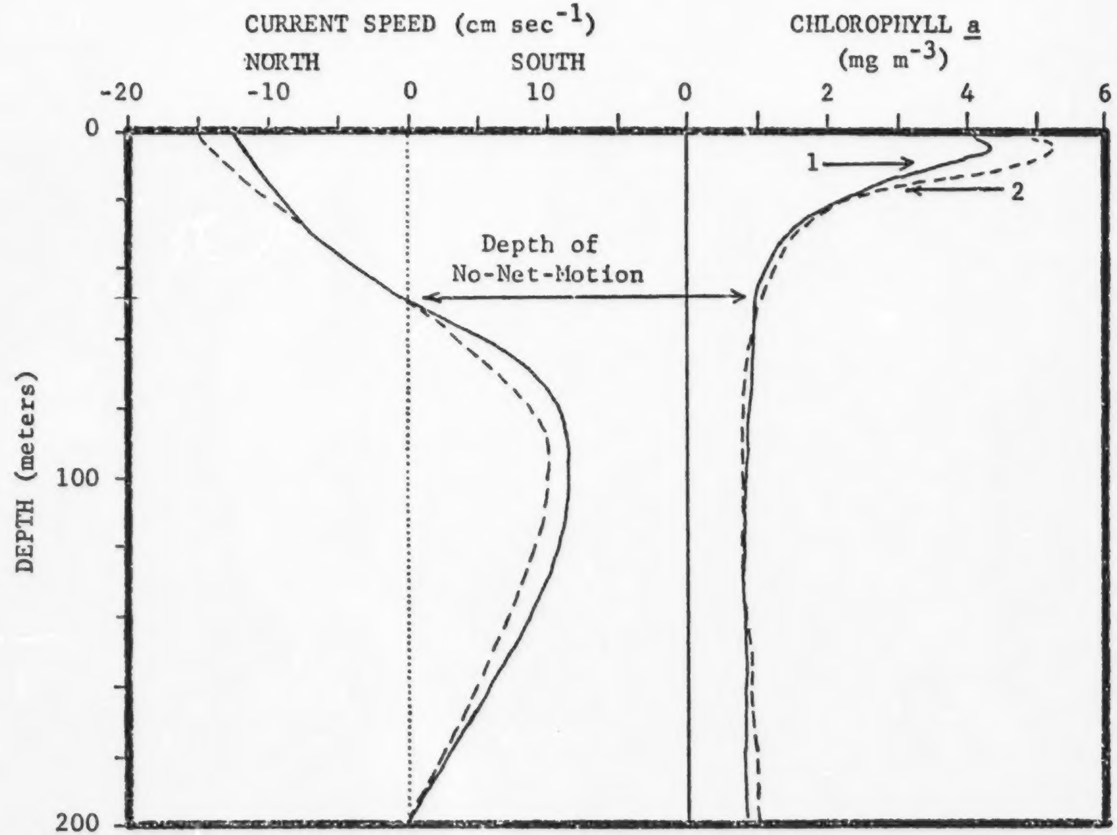
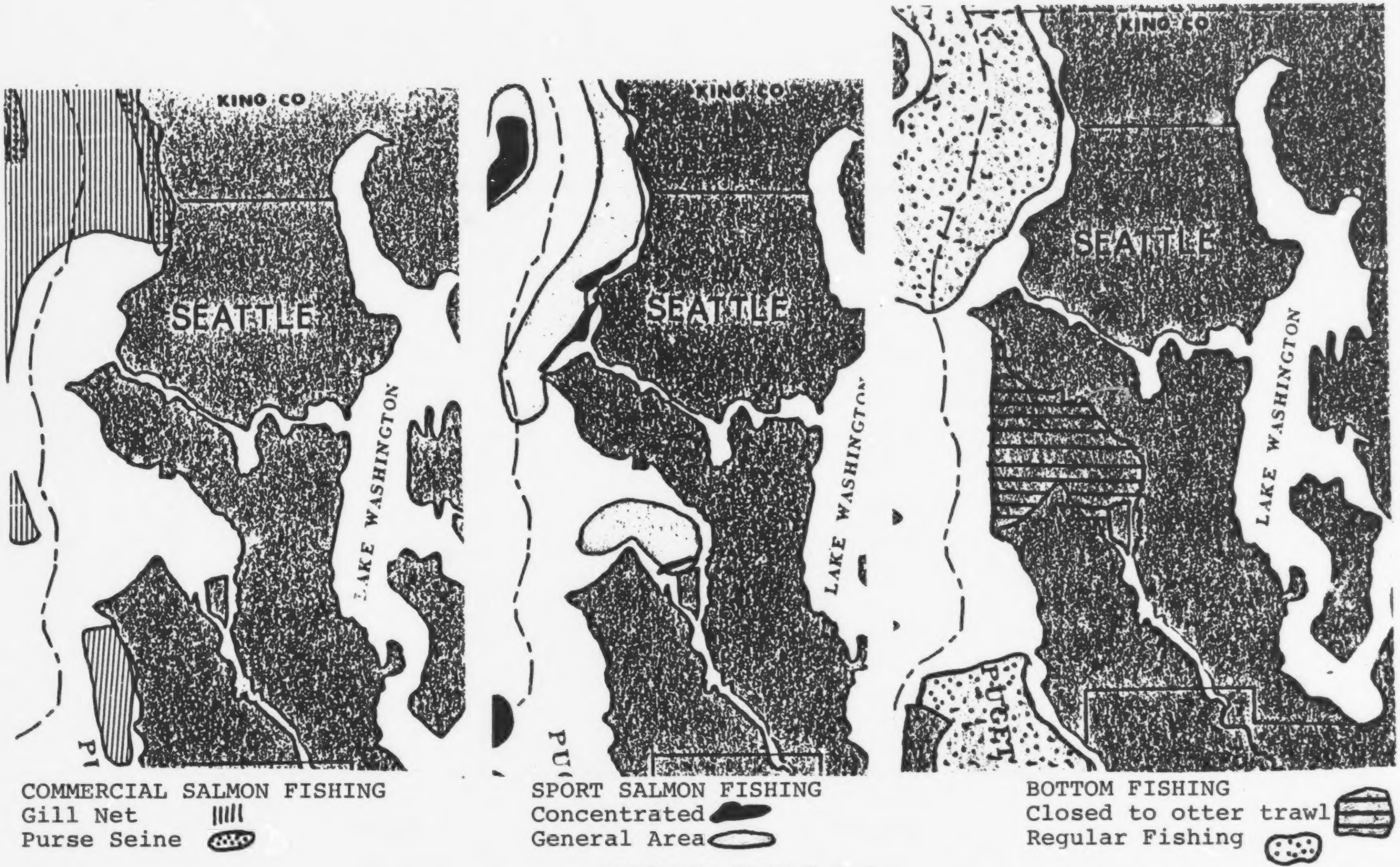

Double Bluff
Alki Point
Browns Point
0
100
200
300
DEPTH (m)
A
B
C
D
E
5 days
1 day
10 days
Admiralty Inlet
Tacoma Narrows

Figure Feedback cycle of net currents in Puget Sound neglecting winds. Notations: A-B, surface water refluxed to depth by tidal action; B-C, southward flow requiring approximately ten days travel time; C-D, upwelling induced by tidal mixing in Tacoma Narrows; E-D, deep water refluxed through Colvos Passage; E-A, northward flow requiring about 5 days travel time between Alki Point and Double Bluff.

Appendix Figure D-2
Feedback Cycle of Net Currents in Puget Sound.



Appendix Figure D-3 Vertical profiles of net currents (left) from Cannon and Laird (solid;1972) and Laird and Galt (dashed; 1975); and chlorophyll a derived from data reported by Winter, Banse and Anderson (1975) for 1966(solid) and 1967(dashed). METRO effluent is usually below 10m (1). The average depth of 1% light level in May is 17 m (2).


KING CO
SEATTLE
LAKE WASHINGTON
PU
KING CO
SEATTLE
LAKE WASHINGTON
PU
KING CO
SEATTLE
LAKE WASHINGTON
PUGET

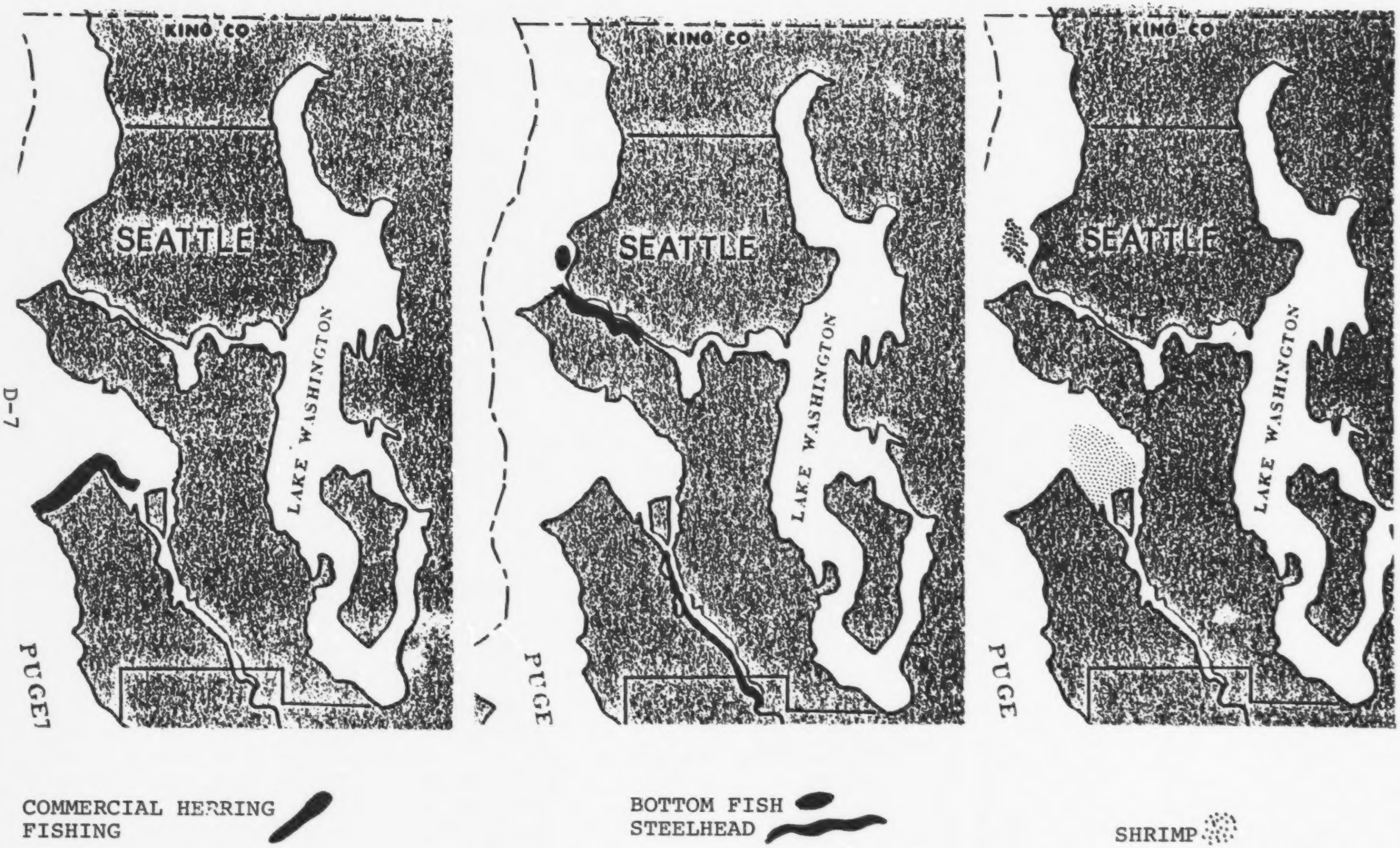
COMMERCIAL SALMON FISHING
Gill Net ||||
Purse Seine ▒

SPORT SALMON FISHING
Concentrated ●
General Area ○

BOTTOM FISHING
Closed to otter trawl ▤
Regular Fishing ▒

APPENDIX FIGURE D-4

COMMERCIAL AND SPORT FISHERIES IN THE STUDY AREA


KING CO
SEATTLE
LAKE WASHINGTON
PUGET
KING CO
SEATTLE
LAKE WASHINGTON
PUGE
KING CO
SEATTLE
LAKE WASHINGTON
PUGE
COMMERCIAL HERRING FISHING
BOTTOM FISH
STEELHEAD
SHRIMP

Appendix Figure D-4 (continued)

STATE WATER QUALITY CRITERIA

CRITERIA FOR STATE OF WASHINGTON WATER QUALITY STANDARDS

CLASSIFICATION			Total Coliform Organisms, MPN/100 ml (a)	Dissolved Oxygen, mg/l	Total Dissolved Gas, % Saturation	Temperature °F (b)	pH (c)	Turbidity, JTU (d)	Toxic Radioactive, or Deleterious Material Concentration	Aesthetic Values
	AA Extraordinary	Freshwater	< 50 (10% > 230)	>9.5	<110	< 60 t=75/(T-22)	6.5-8.5 (0.1)	<5	Shall be less than those which may affect public health, the natural aquatic environment, or the desirability of the water for any usage.	Aesthetic values shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch or taste.
		Marine	< 70 (10% > 230)	>7.0	<110	< 55 t=24/(T-39)	7.0-8.5 (0.1)	<5		
	A Excellent	Freshwater	< 240 (20% > 1000)	>8.0	<110	<65 t=90/(T-19)	6.5-8.5 (0.25)	<5	Shall be below those of public health significance, or which may cause acute or chronic toxic conditions to the aquatic biota, or which may adversely affect any water.	Aesthetic values shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch or taste.
		Marine	< 70 (10% > 1000)	>6.0	<110	<61 t=40/(T-35)	7.0-8.5 (0.25)	<5		
	B Good	Freshwater	<1000 (10% > 2400)	>6.5 (h)	<110	<70 t=110/(T-15)	6.5-8.5 (0.5)	<10	Shall be below those which adversely affect public health during the exercise of characteristic usages, or which may cause acute or chronic toxic conditions to the aquatic biota, or which may adversely affect characteristic water uses.	Shall not be reduced by dissolved, suspended, floating or submerged matter not attributable to natural causes, so as to affect water usage or taint the flesh of edible species.
		Marine	<1000 (10% > 2400)	> 5.0 (h)	<110	<66 t=52/(T-32)	7.0-8.5 (0.5)	<10		
	C Fair	Freshwater	(0% > 1000)	> 5.0 (e)	<110	< 75 t=125/(T-12)	6.5-9.0 (0.5)	<10	Shall be less than those which may affect public health, the natural aquatic environment, or the desirability of the water for any usage.	Aesthetic values shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch or taste.
		Marine	(0% > 1000)	>4.0 (e)	<110	< 72 t=64/(T-29)	7.0-9.0 (0.5)	<10		
	Lake Class	Freshwater	< 240 (20% > 1000)	(g)	<110	(h)	(h)	<5	Shall be less than those which may affect public health, the natural aquatic environment, or the desirability of the water for any usage.	Aesthetic values shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch or taste.

(a) Shown in parenthesis are the maximum percentages of samples allowed to exceed values indicated, when associated with any fecal source.

(b) Water temperature shall not exceed values shown, due in part to measurable (0.5° F) increases resulting from human activities, nor shall such temperature increases, at any time, exceed the (t) value of the formula shown:

t = permissive increase
T = water temperature due to all causes combined

(c) Shall not be within the range shown, with an induced variation of less than units shown in parenthesis.

(d) The natural turbidity conditions shall not be exceeded by more than the value shown.

(e) Dissolved oxygen shall not exceed values shown, or 50% saturation, whichever is greater.

(f) No measurable decrease from natural conditions.

(g) No measurable change from natural conditions.

(h) Dissolved oxygen shall not exceed values shown, or 70% saturation, whichever is greater.

Appendix Table D-1

APPENDIX TABLE D-2

TERRESTRIAL AND MARSHLAND FAUNA OF THE SEWERAGE AREA

AMPHIBIANS AND REPTILES

*Northwestern Salamander	Ambystoma gracile
*Long-toed Salamander	Ambystoma macrodactylum
*Pacific Giant Salamander	Dicamptodon ensatus
*Rough-skinned Newt	Taricha granulosa
*Western Red-backed Salamander	Plethodon vehiculum
*Oregon Salamander	Ensatina eschscholtzi oregonesis
*Tailed Frog	Ascaphus truei
*Western Toad	Bufo boreas
*Pacific Treefrog	Hyla regilla
*Red-legged Frog	Rana aurora
*Spotted Frog	Rana pretiosa
*Bullfrog	Rana catesbiana
*Western Pond Turtle	Clemmys marmorata
Western Fence Lizard	Sceloporus occidentalis
Northern Alligator Lizard	Gerrhonotus coeruleus
Rubber Boa	Charina bottae
*Common Garter Snake	Thamnophis sirtalis
*Western Terrestrial Garter Snake	Thamnophis elegans
Northwestern Garter Snake	Thamnophis ordiniodes

BIRDS

Common Loon	Gavia immer
Horned Grebe	Podiceps auritus
✓Western Grebe	Aechmophorus occidentalis
*Pied-billed Grebe	Podilymbus podiceps
✓Double-crested Cormorant	Phalacrocorax auritus
*Great Blue Heron	Ardea herodias
*Green Heron	Butorides virescens
✓*American Bittern	Botaurus lentiginosus
*Whistling Swan	Olor columbianus
*Canada Goose	Branta canadensis
Brant	Branta nigricans
White-fronted Goose	Anser albifrons
Snow Goose	Chen hyperborea
*Mallard	Anas platyrhynchos
*Gadwall	Anas strepera
*Pintail	Anas acuta
*Green-winged Teal	Anas carolinensis
*Blue-winged Teal	Anas discors
*Cinnamon Teal	Anas cyanoptera
*European Widgeon	Mareca penelope
*American Widgeon or Baldpate	Mareca americana

---

*These species utilize wetlands

✓Species on the 1977 Audubon "Blue List"

Appendix Table D-2 (cont'd)

BIRDS, continued...

*Shoveler	*Spatula clypeata*
*Wood Duck	*Aix sponsa*
*Redhead	*Aythya americana*
*Ring-necked Duck	*Aythya collaris*
✓*Canvasback	*Aythya valisineria*
*Greater Scaup	*Aythya marila*
*Lesser Scaup	*Aythya affinis*
*Common Goldeneye	*Bucephala clangula*
*Bufflehead	*Bucephala albeola*
*Harlequin Duck	*Histrionicus histrionicus*
White-winged Scoter	*Melanitta deglandi*
Surf Scoter	*Melanitta perspicillata*
Common Scoter	*Oidemia nigra*
Ruddy Duck	*Oxyura jamaicensis*
*Hooded Merganser	*Lophodytes cucullatus*
*Common Merganser	*Mergus merganser*
*Red-breasted Merganser	*Mergus serrator*
Goshawk	*Accipiter gentilis*
✓Sharp-shinned Hawk	*Accipiter striatus*
✓Cooper's Hawk	*Accipiter cooperii*
Red-tailed Hawk	*Buteo jamaicensis*
*Bald Eagle	*Haliaeetus leucocephalus*
✓*Marsh Hawk	*Circus cyaneus*
✓Osprey	*Pandion haliaetus*
Gyrfalcon	*Falco rusticolus*
Peregrine Falcon	*Falco peregrinus*
Pigeon Hawk	*Falco columbarius*
Rock Dove	*Columba livia*
Mourning Dove	*Zenaidura macroura*
✓Barn Owl	*Tyto alba*
*Snowy Owl	*Nyctea scandiaca*
Spotted Owl	*Strix occidentalis*
*Short-eared Owl	*Asio flammeus*
✓Common Nighthawk	*Chordeiles minor*
Black Swift	*Cypseloides niger*
Vaux's Swift	*Chaetura vauxi*
Anna's Hummingbird	*Calypte anna*
Rufous Hummingbird	*Selasphorus rufus*
*Belted Kingfisher	*Megaceryle alcyon*
Red-shafted Flicker	*Colaptes cafer*
Hairy Woodpecker	*Dendrocopos villosus*
*Downy Woodpecker	*Dendrocopos pubescens*
*Traill's Flycatcher	*Empidonax traillii*
Western Flycatcher	*Empidonax difficilis*
Western Wood Pee Wee	*Contopus sordidulus*
Olive-sided Flycatcher	*Nuttallornis borealis*
Horned Lark	*Eremophila alpestris*
Violet-green Swallow	*Tachycineta thalassina*
*Tree Swallow	*Iridoprocne bicolor*
Bank Swallow	*Riparia riparia*
*Rough-winged Swallow	*Stelgidopteryx ruficollis*

Appendix Table D-2 (cont'd)

BIRDS, continued...

Sparrow Hawk	Falco sparverius
Ruffled Grouse	Bonasa umbellus
California Quail	Lophortyx californicus
Ring-necked Pheasant	Phasianus colchicus
Virginia Rail	Rallus limicola
*American Coot	Fulica americana
*Killdeer	Charadrius vociferus
*Common Snipe	Capella gallinago
*Spotted Sandpiper	Actitis macularia
*Greater Yellowlegs	Totanus melanoleucus
*Lesser Yellowlegs	Totanus flavipes
*Pectoral Sandpiper	Erolia melanotos
Least Sandpiper	Erolia minutilla
Dunlin	Erolia alpina
Long-billed Dowitcher	Limnodromus scolopaceus
*Western Sandpiper	Ereunetes mauri
*Wilson's Phalarope	Steganopus tricolor
*Glaucous-winged Gull	Larus glaucescens
*Western Gull	Larus occidentalis
*California Gull	Larus californicus
*Ring-billed Gull	Larus delawarensis
*Mew Gull	Larus canus
Bonaparte's Gull	Larus philadelphia
Band-tailed Pigeon	Columba fasciata
Orange-crowned Warbler	Vermivora celata
Hermit Warbler	Dendroica occidentalis
✓Yellow Warbler	Dendroica petechia
Townsend's Warbler	Dendroica townsendi
Black-throated Gray Warbler	Dendroica nigrescens
Yellowthroat	Geothlypis trichas
Wilson's Warbler	Wilsonia pusilla
House Sparrow	Passer domesticus
Western Meadowlark	Sturnella neglecta
*Red-winged Blackbird	Agelaius phoeniceus
*Bullock's Oriole	Icterus bullockii
Brewer's Blackbird	Euphagus cyanocephalus
*Brown-headed Cowbird	Molothrus ater
Western Tanager	Piranga ludoviciana
Black-headed Grosbeak	Pheucticus melanocephalus
*Evening Grosbeak	Hesperiphona vespertina
Pine Grosbeak	Pinicola enucleator
Purple Finch	Carpodacus purpureus
*House Finch	Carpodacus mexicanus
Pine Siskin	Spinus pinus
American Goldfinch	Spinus tristis
White-winged Crossbill	Loxia leucoptera
Rufous-sided Towhee	Pipilo erythrophthalmus
Slate-colored Junco	Junco hyemalis
*Savannah Sparrow	Passerculus sandwichensis
*Barn Swallow	Hirundo rustica
*Cliff Swallow	Petrochelidon pyrrhonota
Purple Martin	Progne subis

Appendix Table D-2 (cont'd)

BIRDS, continued...

Steller's Jay	Cyanocitta stelleri
*Common Crow	Corvus brachyrhynchos
*Black-capped Chickadee	Parus atricapillus
Chestnut-backed Chickadee	Parus rufescens
*Common Bushtit	Psaltriparus minimus
Winter Wren	Iroglodytes troglodytes
*Bewick's Wren	Thryomanes bewickii
*Long-billed Marsh Wren	Telmatodytes palustris
*Robin	Turdus migratorius
Varied Thrush	Ixoreus naevius
*Swainson's Thrush	Hylocichla ustulata
Mountain Bluebird	Sialia currucoides
Western Bluebird	Sialia mexicana
Golden-crowned Kinglet	Regulus satrapa
Ruby-crowned Kinglet	Regulus calendula
*Water Pipit	Anthus spinoletta
Cedar Waxwing	Bombycilla cedrorum
Northern Shrike	Lanius excubitor
Starling	Sturnus vulgaris
Solitary Vireo	Vireo solitarius
Red-eyed Vireo	Vireo olivaceus
Warbling Vireo	Vireo gilvus
Chipping Sparrow	Spizella passerina
*White-crowned Sparrow	Zonotrichia leucophrys
Golden-crowned Sparrow	Zonotrichia artricapilla
White-throated Sparrow	Zonotrichia albicollis
*Fox Sparrow	Passerella iliaca
*Lincoln's Sparrow	Melospiza lincolnii
*Song Sparrow	Melospiza melodia

MAMMALS

*American Opossum	Didelphis marsupialis
Cinereous Shrew	Sorex cinereus
*Vagrant Shrew	Sorex vagrans
*Dusky Shrew	Sorex obscurus
Water Shrew	Sorex palustris
*Marsh Shrew	Sorex bendirei
Trowbridge's Shrew	Sorex trowbridgei
*Shrew-mole	Neurotrichus gibbsi
*Townsend's Mole	Scapanus townsendi
Coast Mole	Scapanus orarius
Various Bats	Chiroptera
*Eastern Cottontail	Sylvilagus floridanus
Snowshoe Hare	Lepus americanus
*Mountain Beaver	Aplodontia rufa
Townsend's Chipmunk	Eutamias townsendi
*Eastern Gray Squirrel	Sciurus carolinensis
Fox Squirrel	Sciurus niger
Douglas's Squirrel	Tamiasciurus douglasi
Northern Flying Squirrel	Claucomys sabrinus
*Beaver	Castor fiber

Appendix Table D-2 (cont'd)

MAMMALS, continued...

Common Deer Mouse	*Peromyscus maniculatus*
*Mountain Deer Mouse	*Peromyscus oreas*
Bushy-tailed Wood Rat	*Neotoma cinerea*
Gapper's Red-backed Mouse	*Clethrionomys gapperi*
*Townsend's Meadow Mouse	*Microtus townsendi*
*Long-tailed Meadow Mouse	*Microtus longicaudus*
Oregon Meadow Mouse	*Microtus oregoni*
*Muskrat	*Ondatra zibethicus*
*Norway Rat	*Rattus norvegicus*
*Black Rat	*Rattus rattus*
House Mouse	*Mus musculus*
*Pacific Jumping Mouse	*Zapus trinotatus*
Porcupine	*Erethizon dorsatum*
*Nutria	*Myocastor coypus*
Coyote	*Canis latrans*
*Red Fox	*Vulpes vulpes fulva*
Black Bear	*Ursus americanus*
*Raccoon	*Procyon lotor*
*Short-tailed Weasel	*Mustela erminea*
Long-tailed Weasel	*Mustela frenata*
*Mink	*Lutreola lutreola*
Spotted Skunk	*Spilogale putorius*
*Striped Skunk	*Mephitis mephitis*
*River Otter	*Lutra canadensis*
Bobcat	*Lynx rufus*
Black-tailed Deer	*Odocoileus hemionus*

APPENDIX TABLE D-3

ADDENDA TO "LIST OF FAUNA OF THE SEWERAGE AREA"

(in Metro Engineers Tasks A5, AIG, B5F-Appendix A)

* Arctic Loon	Gavia arctica
*Red-throated Loon	Gavia stellata
✓Red-necked Grebe	Podiceps grisegena
*Eared Grebe	Podiceps nigricollis
Brandt's Cormorant	Phalacrocorax penicillatus
Pelagic Cormorant	Phalacrocorax pelagicus
*Barrow's Goldeneye	Bucephala islandica
*Oldsquaw	Clangula hyemalis
*Black Turnstone	Arenaria melanocephala
*Sanderling	Calidris alba
Parasitic Jaeger	Stercorarius parasiticus
*Herring Gull	Larus argentatus
Thayer Gull	Larus thayeri
Common Tern	Sterna hirundo
Common Murre	Uria aalge
Pigeon Guillemot	Cepphus columba
Cassin's Auklet	Ptychoramphus aleuticus
Marbled Murrelet	Brachyramphus marmoratus
*Rhinoceros Auklet	Cerorhinca monocerata

*These species utilize wetlands

✓On the 1977 Audubon "Blue List"

Source: Salo, Leo J. "A Baseline Study of Significant Marine Birds in Washington State." for the Washington State Departments of Game and Ecology. September 1. 1975.

APPENDIX TABLE D-4

SUMMARY
OVERFLOW STUDY, August 1976

	Denny (W027)	Madison (023)	Roanoke (132)	Hanford (W032)
Average Overflow Volume (approx mil gal/yr)	40-100	10-40	40-100	40-100
Receiving Waters	Elliott Bay/Puget Sound	Lake Washington	Lake Union	Duwamish-East Waterway/ Puget Sound
Minimum Dilution (general vicinity)	(EBB) 0.1-1.8 hrs 1:1 2.9-3.7 hrs 1:32 (FLOOD) 0-1.7 hrs 1:1 3.1-3.6 hrs 1:15	0.1-1.6 hrs 1:1 3.3-4.8 hrs 1:27	0.1-1.6 hrs 1:1 2.8-3.7 hrs 1:-2	(EBB) 0.1-0.4 hrs 1:1 1.4-2.3 hrs 1:117
Macroscopic Biota	Present - see Table 2- for list. Areas to north and south different	None found	None found	None in plume area; myraids of spionid worms outside plume
Sediment characteristics	Typical appearance for the area; a minimum of blackened sediments	Black, oily	Black, oily	Black, oily
Metals levels	Copper, nickel, zinc as high or higher in biota than sediments	Not measured for biota	Not measured for biota; highest levels of four sites in sediments; associated with oily sediments	Not measured for biota; second highest of four sites for sediments; associated with oily sediments
PCB's levels	North side: quite low; south side: substantial (in sediments)	Quite low (sediments)	Quite low (sediments)	"Substantial" (sediments)
Chlorinated hydrocarbons levels, pesticides	Quite low in biota and sediments	No data on biota; extremely high in sediments (DDT,DDD)	No data on biota; high in sediments, 200 yds south of outfall (DDD) high undane in water, not in sediments	No data on biota; high dieldrin, aldrin in sediments
Coliforms	High through 96 hrs, resuspended by tides, eddies; south side higher counts	High through >48 hrs; south side higher counts	Persist >96 hrs; could be affected by other outfalls nearby	High through >48 hrs; north side higher than south side

APPENDIX TABLE D-5

SELECTED WATER QUALITY CRITERIA
PROPOSED BY U. S. EPA 1975

Parameter	Freshwater Life	Marine Life	Other
Ammonia	0.02 mg/l		
Arsenic			0.05 mg/l drinking water
Cadmium Salmonids	0.0004 (soft water) 0.005 (hard water)	0.005 mg/l	0.01 mg/l drinking water
Other Aquatic	0.004 (soft water) 0.012 (hard water)	0.005 mg/l	
Chlorine Salmonids	0.003 mg/l		
Other Freshwater and Marine	0.010 mg/l	0.01 mg/l	
Chromium	0.3 mg/l	0.3 mg/l	0.05 drinking water
Coliforms (Fecal) Shellfish	14 MPN/100 ml 10% < 43/100 ml		
Copper	0.1 x 96LC50 nonaerated bioassay with resident species		1.0 mg/l drinking water
Cyanide	0.005 mg/l	0.005 mg/l	0.2 mg/l drinking water
Iron	1.0 mg/l		0.3 mg/l drinking water
Lead	0.01 x 96LC50	insufficient data for criterion	0.05 mg/l drinking water
Manganese		0.1 mg/l for marine mollusc consumers	
Mercury	0.00005 mg/l	0.0001 mg/l	0.002 drinking water
Nickel	0.1 mg/l	0.1 mg/l	0.01 irrigation
Phenol	0.001 mg/l		
PCBs	10^{-6} mg/l (1ppt)	10^{-6} mg/l (1ppt)	1ppt in food
Selenium	0.01 x 96 LC50 bioassay		10 µg/l drinking water
Zinc	0.01 x 96 LC50 bioassay		5 mg/l drinking water
Pesticides			
Aldrin-dieldrin	0.003 µg/l	0.003 µg/l	
DDT	0.001 µg/l	0.001 µg/l	
Heptachlor	0.01 µg/l	0.01 µg/l	
Lindane	0.01 µg/l	0.05 µg/l	0.4 µg/l drinking water
Malathion	0.1 µg/l	0.1 µg/l	
Methoxychlor	0.02 µg/l	0.03 µg/l	100 µg/l drinking water

APPENDIX TABLE D-6

METALS LEVELS IN BIOTA
at Denny Street Overflow, August 1976
(mg/kg dry weight)

	Cadmium	Chromium	Copper	Nickel	Lead	Zinc
"Worms" at outfall	0.65	5.6	22	9.4	24	223
Clams; 100 yds south, 30 yds offshore	1.49	11.4	213	17	155*	314
Composite-worms,clams, crabs; 105 yds north of outfall, 30 yds offshore	2	6	115	12	52	203

*Dry weight lead values for intertidal clams (1974) were two orders of magnitude lower (Schell *et al*.) at beach south of West Point: about 5 μg/g dry weight.

APPENDIX TABLE D-7

FECAL COLIFORM EFFLUENT LIMITATIONS AND MONITORING AT METRO'S PUGET SOUND TREATMENT FACILITIES

	Monthly Avg*	Weekly Avg*	Monitoring
Richmond Beach	700/100 ml	1500/100 ml	2/week
Carkeek Park	700/100 ml	1500/100 ml	2/week
West Point	700/100 ml	1500/100 ml	daily
Alki	700/100 ml	1500/100 ml	5/week

*Average based on geometric mean of samples
Source: NPDES permits

APPENDIX TABLE D-8

TOTAL COLIFORM STANDARDS VIOLATIONS FOR PUGET SOUND SHORELINE STATIONS

Year	Percent of Stations (at which 70 MPN/100 ml exceeded) (April-September)
1972	10
1973	3
1974	31
1975	25

Source: Metro Engineers Tasks A5,A1G,B5F

APPENDIX TABLE D-9

Chlorine Toxicity to Marine Organisms

ORGANISM	EFFECT	EXPOSURE
PLANTS		
San Francisco Bay aufwuchs	biomass reduced to less than 30% of controls	0.06 mg/l
Chlorophyll *a*	reduced to 50% of control	0.06 mg/l
Phytoplankton	decreased photosynthesis	.01 mg/l intermittent
INVERTEBRATES		
Strongylocentrotus purpuratus (sea urchin)	inhibition of fertilization	0.05 mg/l 5 min
Urechis caupo (worm)	inhibitation of fertilization	0.20 mg/l 5 min
Phragmatopoma californica (tube worm)	inhibition of fertilization	0.20 mg/l 5 min
Clam (*Mercenaria mercenaria*)	acute toxicity-LC50	<.005 mg/l 48 hrs
Oyster (*Crassostrea virginica*)	acute toxicity-LC50	<.005 mg/l 48 hrs
Shrimp (*Pandalus danae*)	acute toxicity-LC50	0.15-0.21 mg/l 96 hrs (15°C)
Hydroids	growth slightly retarded	2.5-3.5 mg/l 1 hr
Barnacle lavae	80% mortality	2.5 mg/l 5 min
Copepods	90% mortality	2.5 mg/l 5 min
Grass shrimp	low mortality 25% mortality 97.2% mortality	2.5 mg/l 5 min 2.5 mg/l 3 hrs 2.5 mg/l 96 hrs
Amphipods	low mortality 25% mortality 100% mortality	2.5 mg/l 5 min 2.5 mg/l 3 hrs 2.5 mg/l 96 hrs
Lobster (48 hrs old)	50% mortality	16.3 mg/l free Cl 2.02 mg/l chloramine
	decreased respiration rate	0.05 mg/l chloramine 0.10 mg/l free Cl
FISHES		
Ichthyoplankton-yellowtailed flounder	50% mortality	0.1,0.2 mg/l 24 hrs
Plaice eggs	50% mortality 50% mortality	0.64 mg/l 72 hrs 0.105-.12 192 hrs
Dover sole and plaice larvae	50% mortality	.025-.071 48-96 hrs
Metamorphosed fish	50% mortality	.07 .095" 96 hrs

Source: Brungs, 1976.

APPENDIX TABLE D-10

RARE, THREATENED OR ENDANGERED ANIMALS WHOSE RANGE INCLUDES THE GREEN RIVER SEWERAGE AREA

REPTILES

Northwest Pond Turtle	*Clemmys marmorata marmorata*

BIRDS

Western Grebe	*Aechmophorus occidentalis*
Double-crested Cormorant	*Phalacrocorax auritus*
Great Blue Heron	*Ardea herodias*
*Green Heron	*Butorides virescens*
Whistling Swan	*Olor columbianus*
*Aleutian Canada Goose	*Branta canadensis leucopareia*
Sharp-Shinned Hawk	*Accipiter striatus*
Cooper's Hawk	*Accipiter cooperii*
Bald Eagle	*Haliaeetus leucocephalus*
Marsh Hawk	*Circus cyaneus*
*Osprey	*Pandion haliaetus*
Gyrfalcon	*Falco rusticolus*
*Peregrine Falcon	*Falco peregrinus*
*Pigeon Hawk	*Falco columbarius*
Sparrow Hawk	*Falco sparverius*
Barn Owl	*Tyto alba*
*Spotted Owl	*Strix occidentalis*
*Black Swift	*Cypseloides niger*
*Anna's Hummingbird	*Calypte anna*
*Bank Swallow	*Riparia riparia*
Purple Martin	*Progne subis*
*Winter Wren	*Troglodytes troglodytes*
Bewick's Wren	*Thryomanes bewickii*
*Western Bluebird	*Sialia mexicana*
*Hermit Warbler	*Dendroica occidentalis*
Western Meadowlark	*Sturnella neglecta*
*Purple Finch	*Carpodacus purpureus*
*Pine Grosbeak	*Pinicola enucleator*
*White-winged Crossbill	*Loxia leucoptera*
*Golden-crowned Sparrow	*Zonotrichia atricapilla*

MAMMALS

*Keen's Brown Bat	*Myotis keeni keeni*
*Red Bat	*Lasiurus borealis teliotis*
*Townsend's Meadow Mouse	*Microtus townsendi*
*Red Fox	*Vulpes vulpes fulva*

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*Species on preliminary list of rare and endangered animals in Washington State, prepared by the U. S. Bureau of Sport Fisheries and Wildlife (Olympia).

SOURCE: Metro Engineers 1976 Task A5,AlG,B5F Appendix

APPENDIX TABLE D-11

RECOMMENDED TEMPERATURES

Provisional Maximum Temperatures Recommended as Compatible with the Well-Being of Various Species of Fish and their Associated Biota

93°F	Growth of catfish and gar
90°F	Growth of largemouth bass, bluegill and crappie
84°F	Growth of perch and smallmouth bass
80°F	Spawning and egg development of catfish
75°F	Spawning and egg development of largemouth bass
68°F	Growth or migration routes of salmonids and for egg development of perch and smallmouth bass
55°F	Spawning and egg development of salmon and trout (other than lake trout)
48°F	Spawning and egg development of lake trout

(Water Quality Criteria..., April 1, 1968)

APPENDIX TABLE D-12

RECOMMENDED DISSOLVED OXYGEN LEVELS

WARM WATER BIOTA

> 5 mg/l, assuming that there are normal seasonal and daily variations above this concentration

4-5 mg/l, assuming that there are normal seasonal and daily variations above this concentration and water quality is favorable in all other respects

COLD WATER BIOTA

≥ 7 mg/l in spawning areas at all times

≥ 6 mg/l for good growth and general well-being

5-6 mg/l for short periods provided that the water quality is favorable and normal daily and seasonal fluctuations occur

(Water Quality Criteria..., April 1, 1968)

APPENDIX E
Energy Calculation

The energy sale projected to 1990 by the Seattle Lighting Company is 11,647 million kwh (Seattle Lighting, 1976). Assuming the same annual growth rate of 3.7%, the projected annual electricity sale in 2005 would be 20,086 x 10^6 kwh.

The percent of this total electrical energy that the wastewater facilities consume is as shown in the following sample calucation for Alternative A.

$$\frac{\text{purchased electricity by wastewater facilities}}{\text{total electricity to be sold in Seattle}} = \frac{25.26 \times 10^6 \text{ kwh/year}}{20{,}086 \times 10^6 \text{ kwh/year}} \times 100\% = 0.13\%$$

The equivalent household consumption is calculated as indicated below for sample calculation with Alternative A

$$\frac{\text{purchased electricity by wastewater facilities}}{\text{electricity consumption per household}} = \frac{25.26 \times 10^6 \text{ kwh/year}}{0.02 \times 10^6 \text{ kwh/year/household}} = 1260 \text{ household equivalents}$$

The electricity serviced by Seattle City Lighting Company will constitute approximately half the energy consumed by the entire Metro area.

APPENDIX F
REGISTERED HISTORIAL PLACES IN THE METRO AREA

King County

1. Auburn vicinity. Neely, Aaron Sr., Mansion, E of Auburn off WA 18.
2. Kirkland. Kirk, Peter, Building, 620 Market St.
3. Kirkland. Relief (lightship), Central Waterfront at Moss Bay.
4. Redmond. Clise, James W., House, 6046 Lake Sammamish Pkwy. N.E.
5. Redmond. Yellowstone Road, The, 196th St. between the Fall City Highway and 80th N.E.
6. Redmond vicinity. Marymoor Prehistoric Indian Site, 6046 Lake Sammamish Pkwy., N.E.
7. Seattle, Alaska Trade Building (Union Record Building, 1915-1919), First Avenue.
8. Seattle. Assay Office (German Club), 613-9th Ave.
9. Seattle. Barnes Building, 2320-2322 First Avenue.
10. Seattle. Bell Apartments, 2326 First Avenue.
11. Seattle. Broadway High School, Broadway Avenue and East Pine St.
12. Seattle. Building No. 105, Boeing Airplane Company (E.W. Heath Shipyard), 200 S.W. Michigan St.
13. Seattle. Butterworth Building, 1921 First Avenue.
14. Seattle. Coliseum Theater, 5th Avenue and Pike St.
15. Seattle. Colman Building, 811 First Avenue.
16. Seattle. Fire Station No. 18 (Ballard Fire Station), 5427 Russell Ave. N.W.
17. Seattle. Fire Station No. 23, 18th Ave. and Columbia St.

18. Seattle. Fire Station No. 25, 1400 Harvard Ave.

19. Seattle. Iron Pergola, 1st Ave. and Yesler Way.

20. Seattle. King Street Station, Third St. South and South King St.

21. Seattle. Leary, Eliza Ferry, House, 1551-10th Ave. East.

22. Seattle. Moore Theatre and Hotel, 1932 Second Ave.

23. Seattle. Naval Military Hangar-University Shell House, University of Washington campus.

24. Seattle. Northern Life Tower (Seattle Tower), 1212 Third Ave.

25. Seattle. Old Public Safety Building, 4th Ave. and Terrace St. and 5th Ave. and Yesler Way.

26. Seattle. Paramount Theatre, 901 Pine Street.

27. Seattle. Park Department, Division of Playgrounds, 301 Terry Avenue.

28. Seattle. Pike Place Public Market Historic District, roughly bounded by 1st and Western Aves. and Virginia and Pike Sts.

29. Seattle. Pioneer Hall, 1642-43rd Ave. East.

30. Seattle. Pioneer Square-Skid Road District.

31. Seattle. Queen Anne Public School, 515 West Galer St.

32. Seattle. Ronald, Judge James T., House, 421-30th South.

33. Seattle. Storey, Ellsworth, Residences, 260, 270 E. Dorffel Dr.

34. Seattle. Virginia, V. 4250-21st Ave. W.

35. Seattle. W. T. Preston, Lake Washington Ship Canal, Hiran Chittenden Locks.

36. Seattle. Wawona, Seattle Police Harbor Patrol Dock, foot Densmore St.

37. Seattle. Union Station, 4th South and South Jackson Sts.

38. Seattle. Ward House, 4127 Boren Ave.

39. Seattle. Washington Street Public Boat Landing Facility, S. Washington St. west of Alaskan Way.

40. Seattle. Wilke Farmhouse, 1920 Second North.

Also listed in the National Register of Historic Places are three nearby locations which are eligible to be declared Historic Places. In King County, three light stations are eligible: #49, Point Robinson Light Station at Burton; #50, Alki Point Light Station in Seattle; and #51, the West Point Light Station, also in Seattle (See Federal Register, February 10, 1976).

In addition to the officially recognized places of historic interest noted above, Earl D. Laymen, the Historic Preservation Officer for the City of Seattle, has indicated that on the Commodore Way site a farmhouse, circa 1900, located at 4420 25th Avenue West, is worthy of consideration for historic or landmark designation.

The King County Shoreline Management Program (Development of Budget and Program Planning, 1975), and the City of Seattle Shoreline Master Program (Department of Community Development, 1976) add to this list as cultural resources to be protected Fort Lawton, Alki Beach Park, Harbor Patrol Shelter (foot of Washington Street), University of Washington Arboretum and the old University of Washington Shellhouse.

APPENDIX G
DETERMINATION OF CONSTRUCTION EMPLOYMENT

The number of construction jobs for the various alternatives is determined by the following 3-step procedure:

(1) $\frac{\text{Project cost-cost for foundation excavation}}{1.4} = \text{construction cost}$

(2) $40\% \times \text{construction cost} \div 33{,}000\ \frac{\text{dollars}}{\text{jobs}} = \text{construction man years}$

(3) $\text{construction man years} \div \text{5 years to complete construction} = \text{number of construction jobs}$

A foundation must be excavated at the Golf Park, Duwamish (Diagonal Way) sites.

Duwamish excavation cost = $17.4 million
Golf Park excavation cost = $20 million

Sample calculation for employment provided by construction under Alternative B:

$$\frac{81.9 \times 10^6 \text{ (Project cost)}}{1.4} \times .40 \times \frac{1}{33{,}000} \times \frac{1}{5} = \text{142 Construction Jobs}$$

Rounded Off to 150 Jobs